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MONTEREY, CALIFORNIA

THESIS

**INVESTIGATING TEAM COLLABORATION OF THE
FIRE DEPARTMENT OF NEW YORK USING
TRANSCRIPTS FROM SEPTEMBER 11, 2001**

by

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June 2007

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**INVESTIGATING TEAM COLLABORATION IN THE FIRE DEPARTMENT
OF NEW YORK USING TRANSCRIPTS FROM SEPTEMBER 11, 2001**

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Ensign, United States Navy
B.S., The University of Virginia, 2006

Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

On September 11, 2001, more than one thousand people responded to aid in rescue efforts at the World Trade Center in New York City, mobilizing the largest rescue operation in the city's history. The collaborative teamwork demonstrated in this response is recorded in the radio transcripts between responding units and the Manhattan Dispatcher. The goal of this thesis is to use these transcripts to provide a real world example to validate the Structural Model of Team Collaboration, sponsored by the Office of Naval Research. This model focuses on individual cognitive processes during collaboration with the goal of understanding how individuals work together towards making a decision. This thesis also investigates the effects of loss of situational awareness and adherence to standard operating procedure as an indicator of efficient radio communication. Efficient radio communication expedites the process of moving the team towards their ultimate goal; on September 11, 2001, that goal was to rescue the thousands of civilians trapped in the Twin Towers. This thesis uses the Structural Model of Team Collaboration to help the Fire Department of New York understand how it works together as a team, and offer suggested improvements as necessary.

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This thesis is dedicated to my fellow New Yorkers, past and present.

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I. INTRODUCTION

A. SEPTEMBER 11, 2001

1. Timeline

7:59 am American Airlines flight 11 departs Boston, MA, for Los Angeles, CA
8:14 am United Airlines flight 175 departs Boston, MA, for Los Angeles, CA
8:20 am American Airlines flight 77 departs Washington Dulles International Airport for Los Angeles, CA
8:42 am United Airlines flight 93 departs Newark, NJ, for San Francisco, CA
8:46 am AA flight 11 flies into the North Tower of the World Trade Center (WTC) in New York City
9:02 am United flight 175 flies into the South Tower of the WTC in New York City
9:37 am AA flight 77 flies into the Pentagon in Washington, DC
9:59 am the South Tower collapses
10:03 am United flight 93 crashes into a wooded area in Pennsylvania
10:28 am the North Tower collapses

2. Response

On September 11, 2001, over a thousand first responders¹ were deployed to aid the rescue efforts at the WTC. It is impossible to know exactly how many people responded to the WTC because many units self-dispatched, many individual firefighters responded independently, and firefighters just going off duty at 9:00 am were given permission to “ride heavy” with their on duty teams. The Fire Department of New York’s (FDNY) Chief of Department called for a fifth alarm, calling 20 engine² and eight ladder³ companies, in addition to the extra teams required for a High-Rise Building fire⁴.

¹ For a further description of first responders see Chapter III.C.3.

² Engine companies provide sufficient hose to reach the fire and operate effectively, provide relief to those operating the hose lines, and supply the standpipe and sprinkler systems.

³ Ladder companies gain control of elevators, locate the fire floor, determine the best access to it, and provide search and evacuation to people on the fire floor and the floors above the fire floor.

⁴ For further information about the extra units required at a High-Rise Building Fire, see Chapter II.B.2.

Instead, the FDNY responded with 23 engine companies and 13 ladder companies; approximately half of the units in the city, 61% of the city's engine companies, and 43% of the ladder companies. In addition to four rescue teams, the FDNY's single Hazmat team, five squad companies, and support staff, there were nine Brooklyn units staged on the Brooklyn side of the Brooklyn Battery Tunnel awaiting dispatch orders. In the 17 minutes between when the first and second planes crashed in the North and South Towers, respectively, New York City's Fire and Police Departments, Emergency Medical Services (EMS), and the Port Authority of New York and New Jersey (PAPD) had mobilized the largest rescue operation in the city's history (National Commission on Terrorist Attacks, 2004).

3. Evacuation

The National Institute of Standards and Technology estimated that between 16,400 and 18,800 civilians were in the WTC at 8:46 am on September 11, 2001. It is unclear when the evacuation orders were given to the civilians in the towers. Without knowing that a passenger jet had flown into the building, the deputy fire safety director for the WTC gave an announcement over the public address system that those on floors that were effected by the fire to descend to points of safety, at least two floors below the smoke and fire, and wait there for further instruction. Once the deputy fire safety director knew of the cause of the incident, a full evacuation was ordered. This was not relayed to 911 operators, who followed their own high-rise fire SOP, telling civilians to stay where they were and await emergency personnel. At 8:57 am FDNY chiefs called for the evacuation of the South Tower (National Commission on Terrorist Attacks, 2004).

a. Loss

In total, 2,973 people died on September 11, 2001, the largest loss of life on US soil as a result of a hostile attack. At most, 2,152 civilians died at the WTC complex, excluding those first responders in the FDNY, New York Police Department (NYPD), EMS, or PAPD, security personnel in the WTC, civilians who volunteered to help, or passengers on the two planes that crashed into the Towers.

While these are staggering figures, it is beneficial to look at the percentage of those who perished above and below the impact zones. Of those who died 94.64% worked or were to attend a meeting above the impact zone, and only 5.36%, 115 people, worked below the impact zones in both buildings. This incredibly low percentage shows that the evacuation for those below the impact was successful (National Commission on Terrorist Attacks, 2004).

The FDNY lost 343 firefighters, the largest loss of life in any emergency response agency in history. The PAPD suffered 37 casualties, the largest loss by any police force, and the NYPD, which lost 23 members, the second largest loss by any police force (National Commission on Terrorist Attacks, 2004).

B. FDNY

1. Goal of Rescue

Due to the magnitude of the attacks on September 11, 2001, and the location of the fire on the higher floors of the WTC, the high-ranking FDNY officers who first responded at the North Tower labeled the mission primarily one of rescue instead of firefighting. With each floor being approximately an acre in size, and with multiple floors on fire, the FDNY Chiefs determined focused on rescuing the numerous civilians in the building before attacking the fire (National Commission on Terrorist Attacks, 2004). As one chief reported, “We were going to vacate the building, get everybody out, and then we were going to get out” (National Commission on Terrorist Attacks, 2004, pp. 291).

2. Responding with the New York and Port Authority Police Departments and Emergency Services

The FDNY concentrated on the two buildings that were on fire and the evacuation of the civilians inside. The NYPD supported the lobby and controlled the perimeter of the area, managing the evacuation and maintaining order. The PAPD controlled the lower levels of the WTC, the Path Train to New Jersey, and the Subway stations underneath the Twin Towers. The Emergency Services staged and set up triage and transported victims away from the site. Each service followed their respective Standard

Operating Procedures (SOP); the factor that stopped the normal response was the complete collapse of the towers (Doherty, 2007).

C. THESIS GOALS

1. Goals for the Model of Team Collaboration

One goal for this thesis is to validate the Office of Naval Research (ONR) developed model of team collaboration (seen in Figure 1); to see if this model which was developed based on literature on team collaboration is complete.

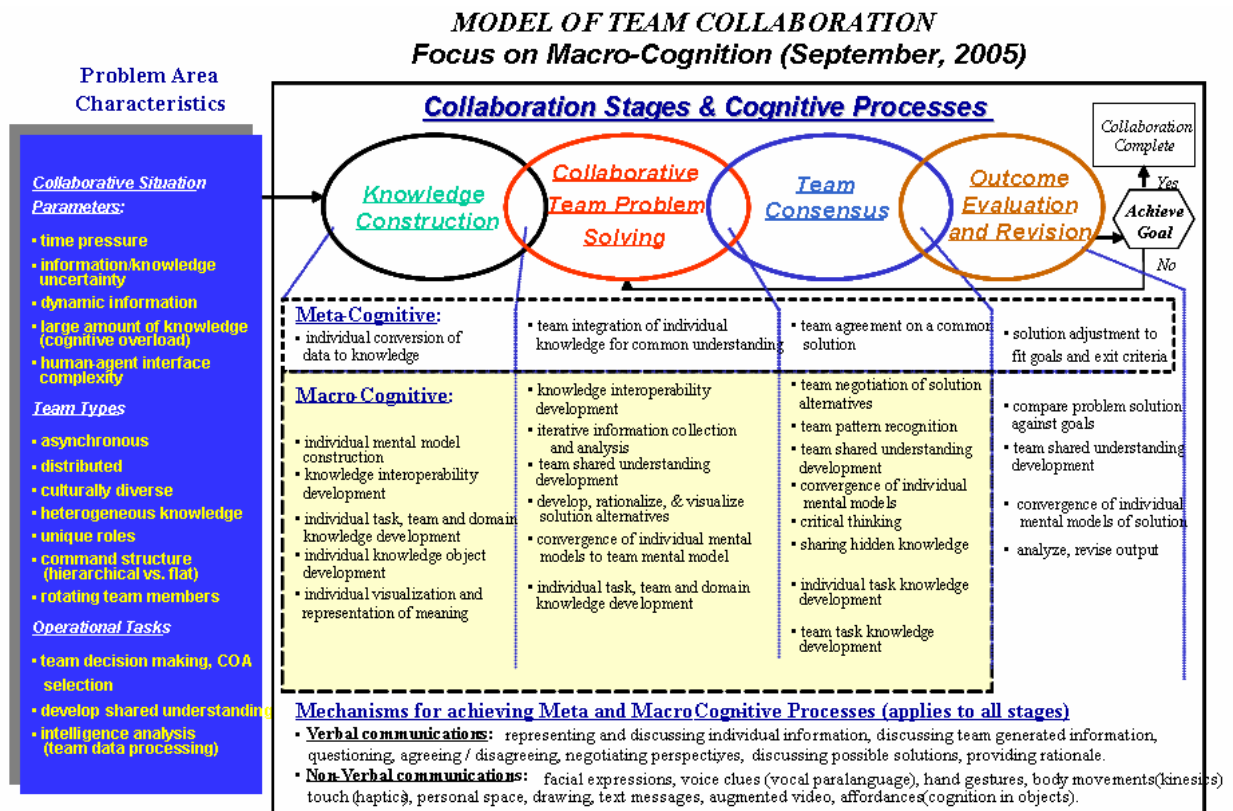


Figure 1. The Structural Model of Team Collaboration (Warner, Letsky, & Cowen, 2004).

The radio communication of the FDNY on September 11, 2001, provides an example of a team collaborating on a very real, very complex, and ambiguous problem. Coding these communication turns as the cognitive processes in the Structural Model of Team Collaboration will help determine if the meta-cognitive and macro-cognitive processes in the model actually represent how teams collaborate to solve real world

problems. If there are some processes exhibited by the firefighters that are not included in the model, they will be proposed as additions to the model. However, in the case where codes are not used, it does not necessarily mean that they should be removed from the model.

2. Goals for the FDNY

The questions investigated in this study work within the highly sensitive framework of a post-September 11th FDNY, NYPD, and PAPD. The events of that day are still very fresh in the minds of those involved, and while the departments are open to constructive criticism because they recognize their shortcomings on that day, it is still a very sensitive area, and outsiders need to tread lightly. As a New Yorker, the author is acutely aware of these sensitivities and worked very carefully to prevent offending or exposing a department.

Since this study analyzed the team collaboration of the FDNY using the transcripts from their communication on September 11, 2001, it is important to provide them with some feedback about the findings of the analysis. The results do not indicate revisions were needed for their communication manual, and that was not the ultimate goal, nor is it within the realm of authority of the author. Investigating examples where the FDNY deviated from their SOP in the September 11, 2001, transcripts will provide the FDNY guidance as to where they may need to focus their attention in training.

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II. BACKGROUND

A. 1993 WORLD TRADE CENTER BOMBING

At 12:18 pm on February 26, 1993, a car bomb exploded in the underground garage at the WTC site. It was not a suicide bombing mission, the terrorist parked the car in the garage, set a timer, and left. The bomb opened a seven story hole, killing six and injuring thousands. This was the first bombing to represent a new level of terrorism that had “no limit of rage or malice” (National Commission on Terrorist Attacks, 2004, p. 72).

The extremely efficient and effective investigation following the attacks gave authorities a false sense of security that they were able to cope with any level of terrorist attack. The Federal Bureau of Investigation (FBI) was able to identify remnants of the truck that housed the bomb and link paper work for the truck rental to terrorists who attempted to enter the United States at John F. Kennedy Airport in New York. The U.S. Attorney was able to prosecute and convict many individuals linked to the attack. This false sense of security carried over into the public sector, which led American citizens to think they were safe from terror attacks. The case also failed to bring Osama Bin Ladin’s terror network to the attention of the public (National Commission on Terrorist Attacks, 2004). The success of the response to the bombing in 1993 also gave emergency responders a false sense of security that the buildings would withstand an attack (Puzziferri, 2007).

1. Improvements Since 1993

During the 1993 bombing the WTC lost the public-address system, emergency lighting system, and all power and communications capabilities. Rescue efforts by the FDNY were hindered by radio malfunctions. To address all of these failures the PAPD spent \$100 million to address physical, structural, and technological problems, in addition to enhancing the buildings’ fire safety plans. A computerized fire alarm system with redundant electronics and control panels, and state-of-the-art fire command stations were placed in the lobby of both towers (National Commission on Terrorist Attacks, 2004).

In 1994 the PAPD installed a repeater system to enhance FDNY radio communication in the WTC. While the PAPD recommended that the repeater be left on at all times, the FDNY only wanted it on when necessary so that it would not interfere with other radio transmissions in the lower Manhattan area. There were activation consoles for the repeater in the fire safety desk in both lobbies of the WTC towers, making the FDNY solely responsible for the repeater.

For the civilians that worked in the WTC there were great improvements from the 1993 attack. People who worked on the many floors of the WTC had evacuation plans, which included meeting areas prior to evacuation. In 1993, general evacuation of the towers took over four hours; in contrast, on September 11, 2001, most of the civilians who were not trapped on the floors above the fire or physically unable to make the descent evacuated in under an hour (National Commission on Terrorist Attacks, 2004).

B. FIRE DEPARTMENT OF NEW YORK

1. Department Makeup

The FDNY is made up of 11,000 firefighters, separated into nine separate geographic divisions. These divisions are in turn separated into between four and seven battalions. Each battalion has between five and eight units, comprised of three and four engine companies and between two and four ladder companies (McGeary, 2007). Each unit has four to five firefighters and one officer, either a captain or a lieutenant. In total there are 205 engine companies and 133 ladder companies.

2. Standard Operating Procedures for High Rise Buildings

Firefighting Procedures Volume 1, Book 5, describes firefighting in High-Rise Class “E” office buildings; topics covered include the problems, features, precautions, and operational procedures of fighting fires in such buildings. High-rise buildings present unique problems for the responding fire units because of the large floor areas, height of the buildings, and the large number of occupants. Class “E” office buildings are office spaces, showrooms, banks, telephone exchanges, civil administration, and assembly occupancies such as restaurants. Specifics of these buildings are:

- 100 feet or more in height
- Vary in area from 2,000 square feet to over 300,000 square feet
- Primarily occupied for business transactions and professional services, including the storage of limited quantities of goods for office uses and purposes
- These buildings also include public and civil services

There are over 800 Class “E” office buildings in New York City, divided into three types: those built before 1945, between 1945 and 1968, and those built after 1968. The divisions are based on the different construction techniques of the time and the resulting building. The buildings constructed before 1945 are “heavy-weight” buildings, weighing 20-23 pounds per cubic foot; buildings constructed between 1945 and 1968 are “medium-weight” buildings, weighing between 10-20 pounds per cubic foot; buildings constructed after 1968 are “light-weight” buildings, weighing 8-10 pounds per cubic foot. The Twin Towers at the WTC both fall into the last category. The North Tower, WTC 1, was completed in 1972, and the South Tower, WTC 2, was completed in 1973. These buildings had important construction characteristics that set them apart from their predecessors:

- The structural steel component of the building was sprayed with a protective fireproofing material
- The ceiling plenums⁵ are extensive and lack fire stopping
- Exterior walls are curtain walls, made up of a combination of glass and metal, with a securing space of 6-12 inches, requiring additional fire stopping
- Exterior windows could not open
- Not required to have a fire tower⁶
- The heating, ventilating, and air-conditioning (HVAC) system which can be used to control the spread of fire and the movement of smoke

While the characteristics listed above represent similarities between most Class “E” High-Rise Buildings constructed after 1968 there is still a great deal of variety in

⁵ A space or enclosure in which air or other gas is at a pressure greater than that of the outside atmosphere. These ceiling plenums were used to return air to the air-conditioning system and vent electrical, communications, and other building support systems and equipment.

⁶ A fire tower is an enclosed stairway connected at each story by an outside balcony or fireproof vestibule vented to the outside (ii).

construction techniques. To accommodate these differences, the firefighting procedures are generalized to allow for broad application. Furthermore, each high-rise building fire will be specific to that building and situation, so the firefighting procedures establish critical priorities and assign chief officers and/or company units, without focusing on assigning individual members or teams of members to the firefighting operations.

a. Incident Command System

Just as the Class “E” High-Rise Building procedures are generalized enough to not constrict responding firefighters, so is the Incident Command System (ICS). ICS is a system designed to manage an expandable situation as the situation develops. It provides a template for the responding firefighters, followed to a certain degree depending on the situation. Since each incident is different, not all parts of ICS are implemented at every incident. The firefighters react and operate according to their other SOP, while still staying within the bounds of ICS (Doherty, 2007).

b. Operations of the Alarm Battalion Chiefs

The “First Alarm Battalion Chief” is the first Battalion Chief on the scene. Upon arriving at the scene he transmits a 10-76, a Notification of a Fire in a High-Rise Building (Communications Manual, 1998). A fire in a high-rise building requires a response of:

- 4 Engine companies
- 4 Ladder companies
- 4 Battalion Chiefs
- 1 Deputy Chief
- 1 Rescue Company
- 1 Squad Company
- 1 CFR-D Engine Company⁷
- 1 “FAST” Unit (Firefighter Assist and Search Team)⁸

⁷ Will be used by the search and evacuation post.

⁸ A ladder company will be designated the FAST unit by the dispatcher, and the dispatcher will notify the ladder company and the incident commander of the assignment (Communications Manual 7-8).

- 1 Command Post Company⁹
- 1 Field Communications Unit
- 1 Mask Service Unit
- 1 Safety Operation Battalion
- 1 Special Operations Battalion
- 1 Safety Coordinator¹⁰ (5th due Battalion Chief)
- 1 High-Rise Unit
- 1 Tactical Support Unit¹¹
- 1 RAC Unit (Recuperation and Care)
- 1 Public Information Officer

If there is visible fire or smoke emanating from the skin of the building, if the fire is deemed serious enough, or if more units are needed to support mass evacuation and/or prevent panic, a second alarm fire is required. A second alarm fire automatically adds four more engine and ladder companies. A second alarm high-rise fire also adds:

- 1 Rescue company
- 2 Battalion Chiefs- one of which will be designated the COMCORD¹²
- 1 Deputy Chief

These numbers continue to multiply for each additional alarm fire, with a maximum of a fire alarm fire. When the Incident Commander requests more than eight engines on the scene, that transmits a third alarm, after 12 engines, a fourth alarm, and after 16 engines a fifth alarm (Gannon, 2007). The attack on the WTC on September 11, 2001 was a five alarm fire.

The First Alarm Battalion Chief sets up the Incident Command center at the lobby command post and becomes the Incident Commander. At the lobby command

⁹ The command post company assists the chief in charge of the lobby command post. This company maintains the command post log, controls the operations of and insures the proper manning of all elevators, and any other duties deemed necessary by the chief in charge of the lobby command post.

¹⁰ The Safety Coordinator assists the Incident Commander in minimizing the threat of death or injury to members.

¹¹ Tactical Support Units carry hydraulic tools, searchlights, air compressors and a motor boat.

¹² The Communications Coordinator, designate at each operations post, responsible for tracking unit assignments and managing communications between tactical and command channels (McKinsey, 2002).

post the Incident Commander has control over all the building systems and receives first hand information on problems in the building and updates on the fire through the building communications network. The lobby command post puts all of this information on the floor plan of the fire floor labeling the location of the fire, and which staircases are used for attack versus search and evacuation. Even when higher ranking officers arrive to relieve the First Alarm Battalion Chief as the Incident Commander, he stays at Incident Command to maintain continuity of operations until the chief in charge of operations dismisses him if his services are no longer needed. As more chiefs arrive they set up the Operations and Search and Evacuation Posts.

c. Communication in High-Rise Building Fires

Since there are so many people working in high-rise office buildings a communication network is necessary to keep all the occupants informed of the emergency and evacuation. The communication network centers around the fire command station in the lobby of the building near the elevator control panel. The fire command station controls loudspeakers located on all floors and in all elevators and stairways, which can be used selectively or collectively. The fire command station also controls the smoke detector systems, sprinkler systems, thermostatic alarms, locked door fail safe systems, fire alarm activation, and the fan system. Unfortunately, Local Law No. 5 only states that these controls must exist and be available to the fire command post, but does not specify a uniform design, so each can have different physical designs and hardware (Communications Manual, 1998).

d. Communication between the Chiefs

The lobby command post is the center of all communications at the scene. The Incident Commander operates on the communication channel; the chief's aide, a firefighter, operates and monitors the primary tactical channel¹³. The communication network consists of radio and hard wire with the dispatcher, the operations post, the

¹³ Chiefs use the tactical radio channels for on-scene communication among chiefs to provide status reports and request assistance, and communication to the respective units under their command to provide directions (McKinsey, 2002).

staging areas, and the search and evacuation post, in addition to handie-talkie radio communications between firefighters (Communications Manual, 1998).

Responding chiefs who are put in charge of the operations post, SAE post, and the staging area must always keep communication with the Incident Commander. The chief in charge of the operations post establishes a communication network on the operational floors, including handie-talkie communication with operating units on the primary tactical channel, and handie-talkie communication with the lobby command post and the staging area on the command channel¹⁴. The chief in charge of the SAE post establishes a communication network with the units under his command on the secondary tactical channel, while establishing communications with the lobby command post and the operations post on the command channel (Communications Manual, 1998).

Chiefs in charge of the posts monitor the primary tactical channel and their respective aides operate the command channel. To maintain order and chain of command all units are assigned to either the SAE post or the operations post. Units working under the two posts do not communicate directly to the lobby command post unless urgent; otherwise all operations communication goes through their respective post commands (Communications Manual, 1998).

3. Radio Communication

Radios used on September 11, 2001, were analog point-to-point radios with six operating channels. Fire companies fighting the fire used the tactical channel, which the chiefs monitored, but the chiefs used their own command channel. Communications on point-to-point radios can only be heard by those in the immediate area of the sender. The larger radio to the Manhattan dispatcher can be heard city wide (National Commission on Terrorist Attacks, 2004).

The FDNY has a cross-band repeater which is able to transmit at a higher wattage and thus reach radios in normally hard to reach areas. It takes a signal from Very High Frequency (VHF) and crosses bands to Ultra High Frequency (UHF) and increases the

¹⁴ Chiefs use the command channels to communicate with each other (McKinsey, 2002).

wattage to 40 watts. Each firefighter carries a handie-talkie radio, which transmit at UHF and normally transmits at five watts. When responding units have to use higher frequencies on their radios it can interfere with any operation in the area. Therefore, citywide, the FDNY only allowed one cross-band repeater operation to occupy the airwaves at one time (Gannon, 2007).

On September 11, 2001, the repeater was not in use because it was not activated correctly. “One button on the repeater system activated the console in the North Tower was pressed at 8:54 [am],” (National Commission on Terrorist Attacks, 2004, pp. 297) making hearing communication possible between the portable radios and the repeater. To transmit on the repeater a second button must be pressed, which was never activated that morning (National Commission on Terrorist Attacks, 2004).

C. TEAM COLLABORATION MODEL

A model of team collaboration was developed by Warner, Letsky, and Cowen in 2004 to emphasize the cognitive processes associated with decisionmaking (see Figure 1). Cognitive processes in this model focus on individual knowledge building, knowledge interoperability, team shared understanding, and developing team consensus. This model focuses on “ill-structured decisionmaking” tasks characterized time pressure, dynamic and uncertain information, high cognitive workload, and complex human-system interfaces. The model focuses on three tasks: team data processing, developing a shared understanding among team members, and team decisionmaking and course of action selection.

While the US military excels in gathering intelligence about their surrounding environment and their current enemy, they lack collaborative planning capabilities to enable efficient, informed decisionmaking. The goal of collaborating early and effectively is to increase organization effectiveness, which is reflected in reduced time to plan an evolution, a strike, or a decision in general. Faster development of knowledge and understanding between all members of the combat team enables decision superiority, reduces operational risk, and increases the pace, coherence, and effectiveness of operations (Hutchins, et al., 2006).

1. Previous Research

Previous research to validate this model of team collaboration was based on communication transcripts from three Maritime Interdiction Operations (MIO) teams and four air-warfare teams. A MIO involves boarding a suspect ship in search of illegal, smuggled cargo. The air-warfare scenario involved identifying hostile and friendly air contacts in the combat information center on a US Navy Aegis ship (Hutchins, Bordetsky, and Kendall, 2007).

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III. LITERATURE REVIEW

A. TEAM PERFORMANCE

In recent years there has been an increase in reliance on teams and multiteam systems to navigate increasingly complex tasks (Salas, Stagl, & Burke, 2004). It is futile, and nearly impossible, for individuals to solve dynamic and complex problems without the help of other team members. While communication technology enables larger teams to work together, there is still a possibility of communication and information overload, hindering team progress. Therefore there must be a balance between transferring information between team members and communication overload.

There is a notable difference between a team and a group; a team is a group, but a group is not necessarily a team. A group is two or more people with a unifying relationship, but this unifying relationship does not have to be a goal. A group could be friends gathering on a Friday after work, a team exists for a task-oriented purpose (Ilgen, Major, Hollenbeck, & Sego, 1995). Members of a group are interchangeable and homogeneous, whereas in a team, each member has specific roles and responsibilities and adds specific information to the team's knowledge base that could not come from anywhere else other than that team member (Orasanu & Salas, 1993). The key differences are the influence, dependency, and accountability between members, making each member an integral part of the success of the team.

A basic definition of a team is a group of two or more people who interact and influence each other, are mutually accountable for achieving common goals associated with organization objectives, and perceive themselves as an entity within an organization (McShane, 2005). This definition can be expanded to include that team members have interdependent tasks, and in order to gain information about another's task members must interact in a professional, social manner (Salas, Stagl, & Burke, 2004). A team's interaction is so critical that the overall mission is impossible without the other team members' collaboration. This also extends to "an implicit contract" between team members to monitor and check on each other's work, often in the form of feedback, to

maximize the performance of the team. In order to maximize the effect of feedback and monitoring, each team member should have general background information about their fellow team members' roles (McIntyre & Salas, 1995).

Tasks required of the team can change within a dynamic environment. This environment depends on the team's situational context, which then influences the team's input, process, and output, and forces the team members to adapt (Salas, Stagl, & Burke, 2004). Still, strictly investigating the team's input, process, and output would be an incomplete study of teams. A large part of the effectiveness of a team is the team's performance while still engaged in the process of making the decision (Ilgen, Major, Hollenbeck, & Sego, 1995).

1. High Performing Teams

Simply bringing individuals together will not produce a team; furthermore, bringing high performing individuals together will not give you a high performing team. Individuals and the team go through different processes: taskwork versus teamwork, respectively. Taskwork is job-specific requirements, usually technical in nature. Teamwork is the process by which the individuals coordinate their individual activities. Taskwork is more commonly measured because it is easier to measure what an individual is accomplishing rather than measuring teamwork (Smith-Jentsch, Johnston, & Payne, 2000). Even though team decisions are a combination of both team and individual processes (Ilgen, Major, Hollenbeck, & Sego, 1995), the decisions made are still attributed to the team as a whole, not the individuals. Studying teams requires studying the aggregate of individuals, not only the individuals themselves; the science of team research wants to make inferences about the complete team, not the discrete members (McIntyre & Salas, 1995).

Orasanu's (1990) study of airline cockpit crews shows four factors that influence the effectiveness of a team. A good cockpit team is (1) explicit in defining the problem and articulating plans and strategies for coping with it, (2) observant of relevant information, (3) likely to explain the rationale for a decision, and (4) able to allocate and coordinate responses among the team. Furthermore, effective teams had stronger

situational awareness, conserved their resources while searching for information, and were very efficient in obtaining the needed information. These qualities of strong team cohesion lead to effective team decisionmaking.

Hutchins, Hocevar, and Kemple (2000) investigated high- and low-performing teams in a simulated military command and control environment. This study focused on communication and how “poor” versus “effective” communication impacts the team’s performance. For example, low performing teams did not use homogeneous and conventional speech patterns, ignoring communication SOP and proper phraseology, not identifying the speaker or the person being addressed and not properly reporting a message received by saying “Roger.”

2. Team Communication

How a team works together is based upon information, communication, supporting behavior, and team initiative/leadership (Salas, Stagl, & Burke, 2004). Communication is the most important part of a team, it is the “glue” that holds the team members together. Team members communicate to pass information, request further information, and share in the construction of the team’s mental model. The proposition that communication is at the bottom of the collaboration hierarchy (Rich, Distributed Collaboration, 2007), but this is only the case in a very low performing team. A team that appreciates and cultivates high quality communication can use it to their advantage towards collaboration (Rich, Distributed Collaboration, 2007).

A decrease in team communication does not imply deteriorating team communication. Leathers (1969, 1972) studied the relationship between communication quality and decision quality. High quality communication is coherent, and well organized, whereas low quality communication is abstract, and includes irrelevant information. High quality communication led to high quality solutions because it was easy for the team members to draw the needed information for the solution from the communication turns. Members of a high performing team are familiar with fellow team members’ roles and responsibilities and the knowledge others possess. Team members know who has access to which pieces of information, and can anticipate who will need

access to pieces of information throughout the course of the decisionmaking process. Knowing who to ask for information and who to give information to is referred to as pushing and pulling information from fellow team members (MacMillan, Entin, & Serfaty, 2004). When these high performing teams are in stressful environments the decrease in communication represents a higher level of communication efficiency, rather than communication deterioration (Orasanu & Salas, 1993). This is because non-essential communication is removed to keep communication to a minimum to free up cognitive resources for decisionmaking.

3. Measuring Team Performance

Performance measurement must support components for measuring the processes and outcomes for both the team and the individuals in the team. Measuring the team's outcome is easier to measure than the process by which the team reached that outcome because either the task was accomplished or not. This is preferred in military and industry teams, where the outcome is the most important part of the decisionmaking process (Smith-Jentsch, Johnston, & Payne, 2000). Team effectiveness can be measured quantitatively in terms of the team's input, the time it takes the team to process the input, and the team's output (Salas, Stagl, & Burke, 2004).

Measuring a team's efficiency in accomplishing the goal or task will lead to qualifying how effectively a team works together. Even performance-oriented teams, who exist to accomplish a goal or task, provide a challenge for defining "success" because even if their goal was not accomplished, it is important to measure their team work process as a measure of their team performance. To measure processing efficiency, raters must identify consistent, observable behaviors so they can be monitored throughout the course of decisionmaking. Consistency is a challenge for measuring team performance, so the more specific the descriptions of the team members' actions, the more accurate the observations will be over the course of making the decision (Baker & Salas, 1992). Still, it is important to note that there is no conclusive evidence that the performance of a team has an impact on the quality of the decision made (Orasanu & Salas, 1993).

B. DECISIONMAKING

There is more to decisionmaking than just the decision, and usually that decision is part of a larger problem. Decisionmaking is not a task; it is part of a sequence of events leading to the decisionmaker accomplishing a goal (Means, Salas, Crandal, & Jacobs, 1993). Team decisionmaking is defined as the process by which interdependent individuals reach a decision to achieve a common goal (Orasanu & Salas, 1993). In team decisionmaking there is an unequal distribution of knowledge spread over all members that must be integrated in order to reach the team's goal. This information integration is hindered by uncertainty, status differences in members, and the failure of one member to appreciate the significance of the knowledge of another. The individuals may still have their own personal goals, motivations, opinions, and perceptions about the decision, but the members must still come together to form one decision for the team. The important distinction between team and individual decisionmaking carries over into the science studying the decisionmaking. The science of individuals cannot be extrapolated to represent the science of teams.

1. Classical Decisionmaking

Classical Decisionmaking is based upon the idea that there are “right” and “wrong” ways to make a decision (Means, Salas, Crandall, & Jacobs, 1993). This theory relies on there being an optimal choice from an array of options, where there is an explicit rule by which to make the decision (Beach & Lipshitz, 1993). Knowing that there are “right” and “wrong” decisions can give the decisionmaker a clearer idea of which should be the better alternative. While this is not always the case, it does help the decisionmaker to know that there is in fact a “right” decision and best course of action to find (Means, Salas, Crandall, & Jacobs, 1993). Scientists relied heavily upon Classical Decisionmaking theory, which focused on laboratory experiments that rarely applied to the “real world.” On the other hand, Naturalistic Decisionmaking focuses on decisionmaking in real world settings where the decisions made are within an environment of dynamic tasks.

2. Naturalistic Decisionmaking

Naturalistic decisionmaking does not occur in a void, it occurs in tandem with complex planning, command and control, design, and diagnostic tasks (Means, Salas, Crandall, & Jacobs, 1993). Since decisionmaking is not a matter of making a single choice, but instead is a series of actions and decisions, the external environment has a large impact on both the outcome of the decision and the decisionmaker.

Naturalistic decisionmaking problems are typically characterized by eight factors that affect the decisionmaker, but not all of the factors impact every decision scenario. The first of these factors is an ill-structured problem where the decisionmaker is unsure about the actual problem, forcing them to form a hypothesis upon which they can base their decisions; these problems also hang in a balance between the problem at hand and any problems that come as implications of the decision. The second factor is an uncertain dynamic environment. Shifting, ill-defined, or competing goals is the third factor impacting decisionmaking; which can oppose each other as goals change, resulting in a larger, overarching goal prevailing. The fourth factor is an action/feedback loop that consists of a string of events instead of the single decision event which may create more problems and require more decisions from the decisionmaker. Time stress is the fifth factor, increasing personal stress on the decisionmaker, resulting in fatigue and loss of vigilance, forcing him/her to make the decision using less complicated reasoning strategies in order to save time. High stakes surrounding the decision is the sixth factor, which may include property or lives. The seventh factor in decisionmaking is the multiple players involved, ranging from peer decisionmakers to those above and below the decisionmaker in the surrounding organizational structure. Finally, the eighth factor is the organization's goals and norms, not only the personal preferences of the decisionmaker.

There is a line between deciding to take an action and acting on that decision. The decisionmaker's ability to move from decision to action is based on their level of cognitive control over the situation and the background knowledge provided to make the decision. An expert has skill-based cognitive control, where there is a continuous, confident, flow between decisions and actions. When the decisionmaker is familiar with

the situation, but not an expert, he or she is at the rule-based level of cognitive control and can handle sequences of subroutines and decisions that together make the larger decision. However, when the decisionmaker is completely unfamiliar with the situation he or she is acting within the knowledge-based level of cognitive control, usually testing solutions by trial and error and cost benefit analysis (Rasmussen, 1993).

3. Recognition-Primed Decision Model of Rapid Decisionmaking

Klein (1993) presents a recognitional model that is used in many real world decisionmaking situations fusing two processes - situational assessment and mental simulation. Recognitional and analytical approaches each have their place in decisionmaking scenarios. The benefit of the Recognition-Primed Decision (RPD) Model instead of the analytical approach is that the RPD describes how an experienced decisionmaker uses their prior experience to solve the problem at hand. Their prior experience enables them to eliminate any possible solutions that have failed in the past (Klein, 1993).

Instead of “making choices,” “considering alternatives,” or “assessing probabilities” decisionmakers in naturalistic decisionmaking scenarios acted and reacted based on prior experiences, while “generating, monitoring, and modifying plans” to meet the needs of their present situation (Klein, 1993, pp. 139). Instead of comparing one solution option with another and deciding which is the better alternative, as in classical decisionmaking, the RPD model focuses on situational assessment by the decisionmaker, considering each option, regardless of when it was thought of, as a valid solution and not as a randomly generated attempt at a solution. The decisionmaker evaluates the solution option for a course of action to see if each would work, rather than comparing the strengths and weaknesses of solutions out of context. Furthermore, the decisionmaker can consider many solutions at once, and the solution accepted does not have to be the optimal solution, but instead a solution that works for the situation at hand. Sometimes the decisionmaker must be able to commit to a solution at a moment’s notice, without a complete analysis of the solution (Klein, 1993).

The RPD model cannot be taught to decisionmakers because it relies on their own inherent knowledge base, and it is based on what these decisionmakers naturally do in the course of making decisions. It can be cultured to help decisionmakers recognize when to use previous knowledge to decrease decisionmaking time. To cultivate a decisionmaker's tendency towards the RPD model, expose them to a wide range of scenarios to provide decisionmaking experience from which they can draw in an actual situation.

a. Klein's Firefighter Study

Klein's RPD model stems from an extensive study of firefighters in urban and suburban environments at different skill levels. Instead of waiting for the next fire to occur to discuss the firefighters' decisionmaking, Klein listened to stories from previous fires and analyzed how decisions were made. From these stories Klein had a wealth of decisionmaking examples in real-time, high stakes, environments.

One of the biggest advances in decisionmaking theory was the power of mental simulation, when a person takes what they have known in the past to predict the future outcome of the situation at hand (Klein, 1999). Klein also investigated the possibility of how these mental simulations can fail when the decisionmaker creates the wrong simulation but does not change it. Still, even with the potential for the simulation to be wrong, Klein does not discount them because, "they are a means of generating explanations, not for generating proofs" (Klein, 1999, pp. 68).

4. Explanation-Based Decisionmaking

When the situation confronting the decisionmaker is new so that the decisionmaker cannot rely upon previous knowledge, the decisionmaker must create a story to explain the disparate pieces of information or fill in the gaps of missing information. In Explanation-Based Decisionmaking evidence towards one solution comes from implications drawn from other information, creating an alternate course of action that is different from the previous courses of action related to the respective individual pieces of evidence (Pennington & Hastie, 1993). The decisionmaker weaves the individual pieces of information into a "story" to build a coherent explanation for

their decisionmaking mental model. When it comes to making the decision the decisionmaker will choose the solution that fits into this mental model “story” created (Pennington & Hastie, 1993).

On September 11, 2001, the emergency responders were forced into use of an explanation-based decisionmaking strategy because the breadth of the attacks was far beyond anything they had encountered. Using their knowledge of general firefighting and knowledge specifically related to firefighting in high-rise buildings, they were able to construct a mental model within which they could make decisions to attack the fire.

5. Collaboration

Research literature has many different definitions of collaboration, depending on the focus of the research and the perspective of the author. Fundamentally, collaboration is the joint effort of two or more agents to construct judgment, and act upon these judgments to achieve a common goal (Nosek, 2003). Basically, collaboration is based on the idea that “two heads are better than one” in that when two people come together they can accomplish more than if they worked alone (Rich, Distributed Collaboration, 2007). Throughout team collaboration it is important that people retain autonomous, independent decisionmaking powers (Wood & Gray, 1991). According to Wood and Gray (1991), it is not crucial that all stakeholders in the decision be present for the decisionmaking process. In terms of team collaboration over the radio, as was the case on September 11, 2001, the stakeholders may not need to actively contribute to the decisionmaking, but they must to be present on the frequency, if their help is required.

The most reliable measure of collaboration is through the use of team communication (Smith-Jentsch, Johnston, & Payne, 2000), as in the Structural Model of Team Collaboration. In regard to the model, collaboration involves the cognitive processes required for joint problem solving to achieve a shared understanding which leads to making a collaborative decision (Hutchins et al, 2006). Appley and Winder (1977) add that collaboration requires that each person is conscious of their motives towards the team and towards their team members, implying there must be a degree of cognition involved. Without collaboration some teams will suffer from the “Robinson

Crusoe syndrome” where the team thinks they are “alone on the island,” despite interdependencies with other teams in the surrounding area (Butts & Petrescu-Prahova, 2005). The need to avoid this “syndrome” and the need to coordinate and collaborate fuel the need to communicate between team members (MacMillan, Entin, & Serfaty, 2004).

According to Pelfrey (2005), collaboration includes collegiality, trust, flexibility, openness, mutual respect, social capital, and pathways of communication; all of these are also key team attributes. On the other hand, inflexibility and cultural restrictions impede collaboration, and therefore impede teamwork. As the number of individual teams working on a problem increases, so does the need for collaboration. With more teams working on a problem there is a tendency for knowledge to become divided between the teams and not reach all of the necessary parties (Pelfrey, 2005). Without collaboration preparedness is incomplete because the team’s shared mental model is incomplete. This was, and still is, a major problem between the Fire Department of New York and the New York Police Department.

Collaboration leads to the formation of a team mind (Klein, 1999). It is not simply the accumulation of individual knowledge and skills; it is a group competence (Rich, Distributed Collaboration, 2007). A team mind is formed by information and knowledge from the team’s different members. It has working and long term memory, limited attention, perceptual filters, and the ability to learn. A team mind also works towards finding a shared mental model. When team members share knowledge, information, and opinions they create a shared mental model, providing a common conceptual framework in which all team members can work. These mental models enable individual team members to carry out assignments in a timely and coordinated fashion without having to negotiate with the other team members during every step (Orasanu & Salas 1993), and lead to informed, and coordinated team action towards the team’s goal.

Teams also form team competencies, team cognition, team Metacognition, and a team identity (Klein, 1999). A team mind is easier to study than an individual mind because the elements towards forming the team mind are seen in communication and

interaction between members, whereas observing an individual mind at work requires the individual to think aloud, usually slowing the process (Cooke, Salas, Kiekel, & Bell, 2004).

a. Forming Storming, Norming, Performing, Transforming, and Adjourning Model

The Forming, Storming, Norming, Performing, Transforming, and Adjourning model helps to explain team collaboration (Tuckman, 1965, qtd. in Rich, Distributed Collaboration, 2007). As with the Structural Model of Team Collaboration (Warner, Letsky, & Cowen, 2004), this model is not linear, and the stages can occur in a linear or circular manner, team members can also return to previous stages if they need to change their solution towards their goal. In the Forming stage the team first comes together, this is driven by whatever force or reason has created the team to accomplish the task at hand. The Storming stage enables all team members to bring ideas to the team's attention, not to reach agreement, but to ensure that the ideas and suggestions of all team members are heard. As the team works together towards their goal, they will change their behaviors and objectives towards that of the team during the Norming stage, making sure that the team is always moving forward. During the Performing stage the team solves the problem at hand, but the team may have to restorm to edit their solutions or change their mutual understanding as the situation changes. When the team has accomplished their goal they separate, during the Adjourning stage.

b. FDNY Collaboration

According to the Final Report of the National Commission on Terrorist Attacks upon the United States (2004), information that was critical for team collaboration on September 11, 2001, was not shared between agencies. Interviews with FDNY chiefs responding at the Incident Command show that they did not have a larger picture of the situation. On September 11, 2001, the NYPD had a helicopter in the air; the FDNY does not contain an air support unit and did not have access to this information. One of the suggestions from the McKinsey Report (2002) was to have a FDNY chief officer in the NYPD helicopters to ensure cross-agency communication.

Furthermore, searching for civilian survivors was inefficient, as both agencies searched the same floors due to the lack of a common search record. It is impossible to say that the lack of coordination between the FDNY and NYPD had a catastrophic effect on the outcome of September 11, 2001, due to the incredibly high number of variables, (National Commission on Terrorist Attacks, 2004). Still, collaboration is definitely an area for improvement for both departments.

C. HOMELAND SECURITY

1. Cycle of Preparedness

It is very difficult, some would argue impossible, to be completely prepared for a terrorist attack because it is impossible to be prepared for every possible attack or situation. Pelfrey's (2005) Cycle of Preparedness (Figure 2) includes planning, training, equipping, exercising, evaluating, and taking action to correct and mitigate the attack.

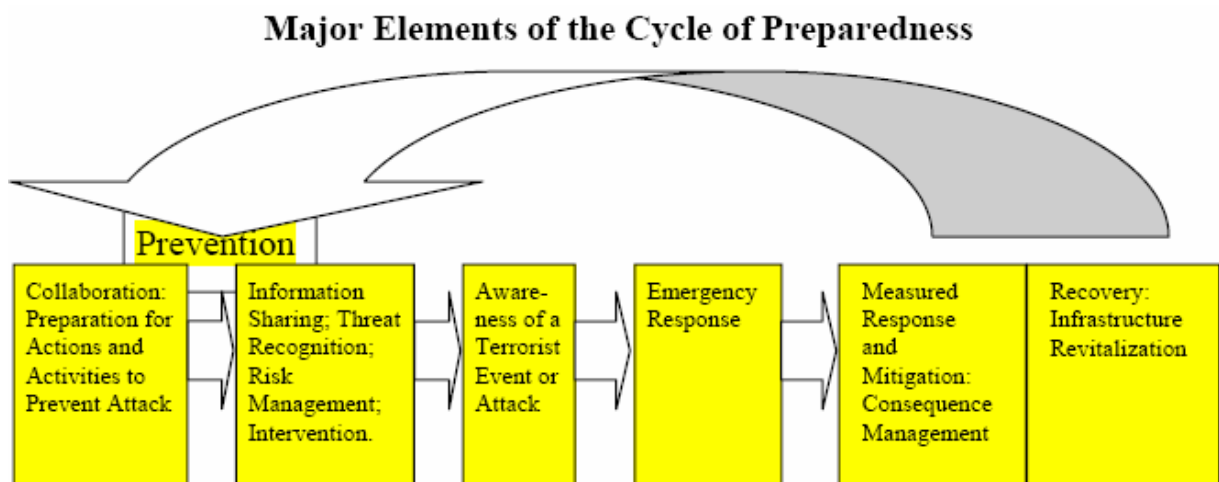


Figure 2. Cycle of Preparedness (Pelfrey, 2005).

The four stages of the Cycle of Preparedness are Prevention, Awareness, Response, and Recovery. The Federal Emergency Management Agency (FEMA) recognizes preparedness as incident-centric, as it is very hard to know exactly how to deal with a situation before the situation arises. The Department of Homeland Security (DHS) defines preparedness as the existence of plans, procedures, policies, training, and

equipment necessary at the federal, state, and local level to maximize the ability to prevent, respond to, and recover from major events (Pelfrey, 2005).

2. Disaster Life Cycle

Fischer (1998) defines five distinct periods in the life cycle of a disaster: the pre-impact period, the impact period, the immediate post-impact period or emergency phase, the recovery period, and finally the reconstruction period.

The pre-impact period is when those likely to be affected by the disaster are warned about its probable occurrence. While there is much political debate as to whether the Bush administration knew of the possibility of an attack on US soil, there was no pre-impact period for the terror attacks of September 11, 2001.

The impact period is the most dangerous part of the disaster, including the actual disaster event. The impact period quickly moves into the immediate post-impact period, so it is the shortest period of the disaster life cycle, but the most time-critical. The immediate post-impact period is the crucial interval when survivors and first responders begin to coordinate an attempt to respond to the disaster and begin search and rescue. During the emergency phase immediate action is required to reduce further losses. These actions include evacuation, accounting for personnel, decreasing all potential hazards, providing first aid, and setting up a field command to gather the necessary authorities to share information about the disaster and relief efforts.

On September 11, 2001, there were several different impact periods and corresponding immediate post-impact periods. The first impact period was when the first plane crashed into the North Tower; the immediate post-impact period was the time to assign alarms to the scene and set up a command post in the lobby of the North Tower. The second impact period was when the second plane crashed into the South Tower, changing the initial immediate post-impact period, increasing the number of alarms and reassigning units from the North Tower lobby to that of the South Tower to set up a command post. It could be argued that there were two additional impact periods when the South and the North Towers collapsed, creating two additional immediate post-impact periods. After the South Tower collapsed the firefighters reacting in the immediate post-

impact period had to give the evacuation order for the North Tower and attempt to find survivors in the rubble. When the North Tower collapsed the immediate post-impact period involved dealing with the incredible magnitude of the disaster and trying to allocate resources accordingly while trying to maintain somewhat of a command structure.

The recovery period includes the surrounding community affected by the disaster and their attempts to return to daily life while reconstructing infrastructure during the reconstruction period. The recovery and reconstruction periods following the attacks on September 11, 2001, have been ongoing since the attack, and are still not complete. Many people have returned to their daily routines, but some survivors chose not to return to their jobs in lower Manhattan. This extends further to those friends and family members who will not be able to recover from the loss of loved ones. Reconstruction is still a challenge in New York with the debate of how to move on while still honoring those who died.

3. First Responders

First responders are those individuals who in the early stages of an incident are responsible for the protection and preservation of life, property, evidence, and the environment.¹⁵ They do not have to be officials; they can just as easily be civilians in the area at the time of the crisis. First responders can be divided into “non-specialist responders” and “specialist responders.” In most cases first responders are not officials, they are people who were present when the disaster occurs. These people will not likely not be trained or equipped to deal with the event (Butts & Petrescu-Prahova, 2005).

Following first response is crisis management. Preserving life is the first priority, but crisis management response also entails containing and controlling the scene, managing and investigating the incident, mitigating and treating harm or damage, and identifying the perpetrators (Pelfrey, 2005). Civilian first responders who were not injured in the attack can provide crucial help to those around them who are suffering

¹⁵ See Chapter I.A.2 for a discussion of the first response on September 11, 2001.

from the disaster (Butts & Petrescu-Prahova, 2005). Throughout all phases, responders must work to eliminate all threats and where threats cannot be eliminated they must be minimized.

D. FIRE DEPARTMENT OF NEW YORK

1. As a Team

The Manhattan dispatcher¹⁶ was located away from the scene of the WTC, making the larger team of the FDNY as a whole was a distributed team. Distributed teams are not necessarily a distinct or unique type of team, and should not be treated as such, but the fact that the team members are distributed makes it important to note that there is a different configuration which can greatly impact team communication (Salas, Stagl, & Burke, 2004). Distribution changes the way members interact and how they receive information. Some distributed teams utilize advancements in technology such as teleconferencing and the internet. The FDNY distributed team uses radio communication to relay information back to the dispatcher and to fellow firefighters.

a. Measure of Success

It is impossible to do a cost benefit analysis for the terrorist attacks on September 11, 2001, because there is no measure of the value of human life. There is also no way to know exactly how many people the FDNY, NYPD, and EMS saved from not only the North and South Towers of the WTC, but from all of lower Manhattan on September 11, 2001.

Prevention is a measure of success for emergency workers and first responders. Again, there is no way to tell how many attacks have been stopped by government officials and how many incidents have been stopped or minimized by the efforts of the FDNY and NYPD. Measure of success is not the absence of these events, but instead the reduction of the likelihood and harm of the events (Pelfrey, 2005).

¹⁶ For discussion on the Manhattan dispatcher see Chapter V.B.1.

2. The McKinsey Report

The McKinsey Report made recommendations for the FDNY in four key areas: operations, planning and management, communications and technology, and family and member support services. Most of the recommendations are based on better communication between the firefighters themselves and communication with other agencies. These recommendations were: create common command and control structures and terminology, deploy interoperable communication protocols, improve the flow of vital information between agencies, plan and execute joint training exercises, ensure traffic information is passed between agencies, and establish a process to enforce security at the incident site (McKinsey, 2002).

E. RADIO COMMUNICATION

Disaster response depends on a variety of formal and informal factors. This is especially evident in communication during a crisis. Technical constraints, formal roles, and SOP are called into question when those responding must cope with the changing information they are provided and the changing demands at the scene of the incident (Butts & Petrescu-Paohova, 2005).

1. Radio Interoperability Problems

Radio interoperability has moved to the top priority for the Department of Homeland Security funding. Currently, “\$350 million has been earmarked for the purchase of equipment, but an operational system is still years away” (Bolstad & Endsley, 2005, pp. 13). The problem with new communication equipment is that it must work with the equipment currently in use (Bolstad & Endsley, 2005). Even though it may top the list of DHS priorities, there are still major issues with seeing any of the new technologies in the field within in the near future. “Police and other emergency agencies responding to Hurricane Katrina were plagued by the same communications problems exposed by the World Trade Center bombing in 1993, yet a solution is still considered years away” (Kerr, 2005, in Timmons & Hutchins, 2006).

In 2006, Ron Timmons published a thesis at the Naval Postgraduate School investigating radio interoperability through an analysis of unacknowledged, repeated, confused/unclear/questionable, and exclamatory/excited messages in radio transmissions from a Regional Fire Training Exercise in Texas. Only 20.6% of radio communication fell into the anomaly type of transmissions. To reduce these occurrences, Timmons suggests that prioritizing message traffic should be part of initial training. He also mentions the idea of having assigned personnel at the scene of the emergency to monitor communication on the radio.

In his analysis of the radio communication of September 11, 2001, Timmons (2006, p. 58) suggests that changes to the radio procedures are needed to:

1. Manage and reduce the amount of radio transmissions
2. Establish procedures and policies for treatment of large numbers of casualties without the need to call for help individually for each one
3. Command and control from a detached perspective aids in the quality of the information provided and in the vocal emotion control of those training

Errors in radio transmissions are not always necessarily due to hardware failure, sometimes they are the result of human error (Timmons, 2006). Timmons found there were also ergonomic problems with the radios, and suggests making radios more intuitive to use, so that the more higher functions on the radios are easy to find, understand, and use (Timmons & Hutchins, 2006).

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IV. THE STRUCTURAL MODEL OF TEAM COLLABORATION

A. FOCUS OF THE MODEL

A model is not a system or process, but instead it is a representation of a system or process, that enables researchers to hypothesize and predict the system or process (Warner, Letsky & Cowen, 2003). There have been many models of team collaboration (Orasanu & Salas, 1992; Rogers & Ellis, 1994; Stahl, 2000; McNeese, Rentsch & Perusich, 2000; Hurley, 2002; Noble, 2002). The Structural Model of Team Collaboration was developed by Warner et al. (2004) under the Office of Naval Research (ONR) sponsored Collaboration and Knowledge Integration program. The model can be seen in Figure 1.

The Structural Model of Team Collaboration focuses on the team member's cognition during the various stages of collaboration. Warner, Lesky, and Cowen (2003) define cognition as a person's awareness of his/her own conscious thought. Cognitive processes are represented at two levels: meta-cognitive, and macro-cognitive (Warner et al., 2003). Metacognition refers to when a person is aware of, and can control, his/her own cognitive processes. These cognitive abilities include information processing, and verbal, inductive, and deductive reasoning. Cognitive stress is defined as cognitive events, properties, or operations due to task demands that exceed a person's normal processing capacity, preventing the person from executing cognitive processes effectively (Hamilton, qtd. in Morgan & Bowers, 1995). Macro-cognitive supports team member activities within the specific cognitive stage.

This model of team collaboration is a starting point for understanding a team member's cognitive mechanisms during team collaboration. The objectives of this model are to understand cognitive mechanisms and their relationships during team collaborative problem solving, to provide a model-based approach to experimentation of team collaboration, to identify and prioritize required areas of research in team collaboration, and to serve as a design guideline for an agent-based support tool for team collaboration

(Warner et al., 2003). The model focuses on team decisionmaking and course of action selection, developing a shared understanding between team members, and intelligence analysis, or team data processing.

With all of the qualitative interaction between team members, a strictly quantitative analysis of team interaction and performance is incomplete. The team collaboration model can help quantify the qualitative using a series of codes for team member communication. The cognitive processes corresponding to the model's codes can be found in Appendix A.

B. MODEL COMPONENTS

1. Input

Input to the collaboration model includes information that the team will use towards their solution. Input is not limited to pieces of evidentiary information, but instead includes information about the surrounding environment in which the team is working. For example, team member expertise, organizational structure, team member roles and responsibilities, resources available, and supporting collaboration technology all contribute to the team's environment, which will impact the degree of collaboration and the overall success of the team. A description of the problem task to be solved, projected events and future information, and the certainty of information are also inputs to the model, and are examples of information the team will use towards their solution (Warner et al, 2003).

There are four stages (seen in Figure 1) that occur between the input and the output, which is the solution generated by the team. *Team knowledge base construction*, *collaborative team problem solving*, *team consensus*, and *product evaluation and revision* are the four stages of collaboration included in the model. These stages do not have to occur sequentially, and the last stage includes a revision feedback loop, so the team can iterate through the stages until they reach the final solution.

2. Team Knowledge Base Construction

Team knowledge base construction is the first stage of the Structural Model of Team Collaboration. This stage includes the very basic ground work, including identifying and understanding the problem. The first stage is crucial in opening the communication pathways between team members, forming a bond of trust between members, leading to team cohesion. The cognitive processes in this stage and their codes can be found in Appendix A.

In this stage team members are gathering information for team knowledge, trying to understand the task at hand to create individual mental models, which will be synthesized into a team mental model. It is important to note that individual knowledge and team knowledge are different. If an individual does not think the rest of the team needs a piece of information, they filter the information flow to the rest of the team instead of overwhelming the communication network with unnecessary information. At the same time, individuals do not need to know all of the team's combined information.

3. Collaborative Team Problem Solving

In *collaborative team problem solving* the team combines their individual mental models towards the team's mental model. Once a mental model is established, individual team members continue to collect and analyze information to add to the growing mental model. Incoming information can also contradict previous information, and it is up to the team to decide which information is valid and which should be eliminated from the team's knowledge. From this mental model the team works together to develop practical solution options to the problem. To create more feasible solution options the team can break the problem down into smaller, more manageable problems.

4. Team Consensus

Team consensus begins when the team has many different solution options from which to choose. As the team deliberates and decides which solution(s) to pursue, they are in the *team consensus stage*. While the team is focused on finding the optimal solution, they must also stay up to date on any issues left to be solved. To prevent

backtracking to ideas and possibilities they already discussed, the team needs to keep track of what they have already done, what they are currently working on, and where they are headed, while always maintaining the team's mental model of the situation and the problem.

5. Outcome Evaluation and Revision

The *outcome evaluation and revision stage* enables the team to analyze, test, and validate the agreed solution against the team's goal for the problem at hand. Revision is a very important part of this stage due to the potential that the team's solution does not work and needs adjustment. This revision stage provides a feedback loop for the entire model, letting the team start over again until they find the optimal solution.

6. Output

Output from the model depends on what type of product the team was to produce. In terms of collaboration, the final output is not necessarily the most important part of the team's work; how the team worked together is a very important process.

C. MODEL INTRICICIES

There are some specific distinctions in the Structural Model of Team Collaboration. For example, it is important to note the difference between data, information, knowledge, and understanding. *Data* is a fact or statement of an event without any relation to something else. *Information* requires the understanding of a relationship of some kind, for example, a cause and effect relationship. *Knowledge* is pattern recognition that provides a higher level of predictability between what has happened and what will happen next under the person's prediction. *Understanding* is a cognitive, analytical, and probabilistic process synthesizing old and new knowledge. Understanding is the guiding force behind transitioning from data to information to knowledge (Bellinger, 2004 in Warner, Letsky, & Cowen, 2005).

D. FDNY IN THE MODEL

1. Team Knowledge Base Construction

In the first stage of the structural model of team collaboration, *team knowledge base construction*, the team opens the needed communication network. For the FDNY this required establishing radio communication with the Manhattan dispatcher as well as between different stories of the WTC. The Incident Command post has to be in communication with the operations post, SAE post, and the staging area.¹⁷ Firefighters at the scene formed mental models and relayed the information back to the Manhattan dispatcher. The dispatcher pieced together these individual mental models to form the larger mental model in which the FDNY could now operate to deal with the attack on the WTC. The FDNY stays in the *team knowledge base construction phase* throughout the entire evolution since they are constantly passing information and making mental model adjustments to the dispatcher to keep the dispatcher informed of changes at the scene.

2. Collaborative Team Problem Solving

During the *collaborative team problem solving phase* the team works together to create a plan to solve the problem. At the Incident Command Post in the lobby of the North and South towers the FDNY chiefs worked together to create a plan. Due to the level of the attack, it was immediately decided to be a rescue mission (National Commission on the Terrorist Attacks Upon the United States, 2004). According to FDNY protocol, the problem was divided into smaller pieces, dividing the chiefs into the operations post, SAE post, and the staging area. As it became apparent that more resources were needed at the scene, more alarms were added to the fire. In total, the attack on the WTC was a five alarm fire. The major mental model change at the Command Post was when the South Tower collapsed. The mission in the North Tower now became one of strict evacuation.

The overflow of information made it important for the chiefs at the Incident Command Post to filter out old and new information to decipher which was factual and

¹⁷ See Chapter II.B.2.d for a discussion of the Incident Command Post and the duties of other responding chiefs.

pertinent to the situation at hand. For example, there was a report that the plane that flew into the South Tower was a “green bomber style aircraft” which was incorrect and needed to be filtered and corrected by the collaborating parties (see Appendix A). There was also a rumor that a third plane was coming into the towers, but the Incident Command Post and the chiefs in charge on the upper floors of the towers assured the responding firefighters that the plane in the air was their own (Zirinsky et al., 2002).

3. Team Consensus

The FDNY chiefs at the scene of the WTC were able to decide on solution options quickly because they could rely on FDNY SOP for regular response actions. The problem of dealing with an attack on the scale of September 11, 2001, was not as easy because few SOP responses applied. The chiefs at the Incident Command Post continually moved between the *collaborative team problem solving stage* and the *team consensus stage* regarding solution options for the various problems.

4. Outcome Evaluation and Revision

For the smaller, more manageable problems, the FDNY was able to reach a consensus and go through the entire collaborative cycle included in the model to the *outcome evaluation and revision stage* of the model. For example, the problem of getting the firefighters to the scene is usually accomplished by using the buildings’ elevators. When the elevators were broken due to the blast from the impact of the plane, the chiefs modified their plans and the firefighters used the stairs to climb to the fire. In the larger problem of evacuating civilians and putting out the fire in the WTC, the chiefs never reached the *outcome evaluation and revision stage* because the buildings collapsed before they had time to see their solution through to completion.

V. METHODS

A. RELEASE OF TRANSCRIPTS AND RECORDINGS

On March 24, 2005, the New York State Court of Appeals ruled in a four to three decision that in the case of The New York Times Company v. City of New York Fire Department the FDNY was required to disclose firefighters' oral histories, and the tapes and transcripts of radio transmissions from September 11, 2001. The release was subject to removal of any personal, painful, or embarrassing statements (Herrmann, 2005). The *New York Times* argued that under the Freedom of Information Law (FOIL), a democratic government belongs to the people and the people have full access to the records used in the decisionmaking process of government agencies (Herrmann, 2005). The FDNY contended that the recordings were official agency records, and that disclosure would be an invasion of personal privacy for all members of the department that were still greatly affected by the tragic events of September 11, 2001. The New York State Court of Appeals had to balance the right of individual privacy with the right of informing the public (Herrmann, 2005). It was determined that the public could determine what information was valuable and important, and that the government agency could not make that decision for them by withholding information (Herrmann, 2005). The transcripts of the dispatch calls and oral histories are available on the *New York Times* website at:

http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met_WTC_histories_full_01.html. The transcripts and recordings have since made their way to other websites on the internet, all stemming from the court battle between the *New York Times* and the FDNY.

Recordings for this thesis were also obtained from FDNY library records, located at Mand Library. These recordings included the various dispatch radio frequencies, the Port Authority radio repeater, and 911 calls made to fire and police department operators. These recordings were not used, as they did not show the FDNY working as a team as well as the dispatcher recordings. Also, this study chose to draw from recordings that

were easily accessible by the public via the *New York Times* instead of having to go through the Mand Library. These transcripts of the Manhattan Dispatcher recordings can be found in Appendix B.

This study used the recordings and transcripts between the Manhattan dispatcher and those units responding to the scene of the WTC to demonstrate how the FDNY collaborates as a team. The communication between the Manhattan dispatcher and the responding units show interaction between a distributed and a collocated team. While the responding firefighters were all working together as a collocated team, their interaction with the Manhattan dispatcher is one of a distributed team. The dispatcher is located in Central Park (Gannon, 2007) and therefore removed from the scene, only receiving information passed from those firefighters in the field. The information passed is a result of the collaboration of those firefighters at the scene.

B. RADIO OPERATORS

1. Manhattan Dispatcher

The dispatcher is a civil service position, requiring experience and training in emergency work. Dispatchers are usually former 911 telephone operators who have the required experience. Each borough in the City of New York has a dispatcher, located in a park, based on the theory that a park is isolated and therefore the building that houses the dispatcher is safe from attack, preserving communications for that borough. The Manhattan dispatcher is located in Central Park (Gannon, 2007).

Dispatcher offices have large maps showing where each FDNY company is located, whether or not they are in service, and if they are responding to an alarm. There are multiple dispatchers working each shift. They take turns transmitting to companies, monitoring computers receiving alarms from the 911 telephone system, and answering alarms from street boxes and telephone calls. Normally a dispatcher can make a decision by following SOP, but there is a supervising dispatcher for each shift to handle any necessary decisionmaking that falls outside of the prescribed protocols (Gannon, 2007).

Dispatchers are responsible for maintaining discipline on the air and determining message priority (Communications Manual, 1998). When the radio traffic becomes too

congested the dispatcher can sound a tone dash attention signal to designate which unit should transmit. This same tone applies if the unit called does not respond promptly. Field units must promptly reply to the dispatcher and promptly comply with all orders from the dispatcher.

a. Goals of the Manhattan Dispatcher

The dispatcher is in charge of assigning units to respond to an alarm. The dispatcher selects and notifies each responding unit. Selection depends on the unit's status, maintained in MDT (Mobile Data Terminals) or PC/ATS (Personal Computer/Alarm Teleprinter Selector). The MDT is the computer and the corresponding printer that shows the response on a screen as well as a printout of the location of the fire, the assignment, and the type of emergency. The MDT is located in an engine or ladder truck and can send and receive information. In the front of each firehouse is the housewatch area with a PC/ATS, monitored by the housewatchman, who will alert everyone in the house if they are called upon to respond. In the case that this system is offline, the dispatcher can use the voice alarm system, which goes directly into company houses. If the voice alarm system is down there is a department telephone to reach companies.

The incident commander asks for resources from the dispatcher to mitigate the incident at hand. It is the job of the dispatcher to answer these needs as completely and quickly as possible. A request that is out of the ordinary from normal protocol may require an approval from a dispatch staff chief (Communications Manual, 1998). When the incident commander at the scene of the alarm requests more units to respond to the scene, he requests second/third/fourth/fifth "alarms." The dispatcher is also responsible for assigning these units to further alarms. In the case of unusually high fire traffic, units en route to an alarm may be redirected to another alarm. The dispatcher is strategy-oriented, focusing on moving the responding units to the correct staging area locations.

2. Incident Commander

In July 2001, the mayor of New York City, Mayor Rudolph Giuliani, updated the "Direction and Control of Emergencies in the City of New York" directive to designate

an Incident Commander. One agency is labeled the incident commander, but in the case that the emergency at hand is multifaceted to the point where no one agency stands out as the incident commander, then the City of New York's Office of Emergency Management will appoint the role as the situation demands. In the case of September 11, 2001, the FDNY had control of the Incident Command Post, but there were no senior NYPD officers at the Post to collaborate the response for both agencies (McKinsey, 2002).

a. Goals of the Incident Commander

From the Incident Command Post, the Incident Commander manages all aspects of the incident response (McKinsey, 2002). The incident commander is responsible for the management of the City's response to the emergency at hand (National Commission on Terrorist Attacks, 2004).

3. Radio Repeater

The repeater in the WTC was tested and deemed inoperable by the FDNY Chiefs early in the response. Therefore, any firefighters that were tuned to the repeater channel out of habit because that was the normal response could not communicate with the command post (McKinsey, 2002).

4. Field Communications

The overall command post consists of the high ranking FDNY officers at the scene, including senior chiefs and commissioners. The high ranking officials that make up this part of the command post are referred to as "Field Comm." The vehicle in which that they are housed is called the Mobile Command Vehicle (National Commission on Terrorist Attacks, 2004).

a. Goals of Field Comm

Field Comm has two main purposes: relay information between the overall operations command post and the dispatcher, and track all units operating at the scene on a large magnetic board (National Commission on Terrorist Attacks, 2004). This

magnetic board was extremely inaccurate on September 11, 2001, because it was very difficult to keep track of who was responding where. This board was destroyed when the South Tower collapsed.

C. COMMUNICATION CODING FOR 9/11 TRANSCRIPTS

The communication transcripts were analyzed and rated using the cognitive coding categories and definitions included in the Structural Model of Team Collaboration (see Appendix A). Radio transmissions were coded to represent the speaker's different cognitive processes. One cognitive speech turn sometimes contained multiple cognitive processes, which are represented as different codes in the model. Using the definitions and examples provided in the model's description, the speech turns were coded as one of the 23 cognitive codes in the model.

Coding can be subjective, based on the interpretation of the coder, according to the definitions for the cognitive processes included in the model. There was also a degree of leniency when applying the definitions, especially when the descriptions stressed "all" of the team members collaborating. In a team as large as the FDNY, it is impossible to expect all of the team members to contribute to a single decision. Therefore, when all of the *necessary* team members came together to collaborate on a topic it was coded to reflect that all team members were involved.

The same leniency applied when coding communication turns as an individual. When an individual transmits on the FDNY radio they are not usually expressing their own personal opinions or knowledge, instead it is the knowledge and opinion of their small unit team. These small teams are the engines, ladders, and other special units that make up the FDNY. On the radio these teams were treated as individuals because in the grand scheme of the decisionmaking team they represented an individual opinion. The communication between these smaller teams is not recorded, and therefore, impossible to code in tandem with the larger radio communication.

1. Inter-rater Reliability Analysis

To check for coder bias and to test the validity of the Structural Model of Team Collaboration codings, the author and a second coder coded the communication turns and compared their results. Two people coded the communication transcripts to determine the extent that the two coders agreed. These differences lead to an analysis of inter-rater codings to examine the degree of subjectivity included in the model. When different coders code many of the communication turns as the same cognitive process, the model is reliable.

Calculating the inter-rater similarities depends upon the total number of communication turns, the number of different codes, and the number of codes that are the same. In the case of the two coders in this analysis, there were also a number of codes that came about from discussing the codes together. These codes fall into a different category, as neither coder labeled it on their own.

D. ADHERENCE TO STANDARD OPERATING PROCEDURES

General SOP exists to give those people involved a prescribed course of action for any given circumstance. Specific to radio communication, SOP focuses on phraseology on the radio, including identifying the speaker, the addressee, and passing the message in the most succinct, informative way possible. The FDNY has SOP manuals for radio communication and firefighting in high-rise buildings. September 11, 2001, put a strain on FDNY SOP because the attacks were on such a massive scale, far beyond the realm of possibility of anything prescribed in the SOP.

Communication SOP outlined in the Communication Manual (1998) requires certain information to be included in any radio transmission. These requirements include that the sender identify himself and who they are addressing, and include any and all specific available information about the purpose of the transmission. When these requirements are not met the recipient and those listening to the radio are not well informed and cannot properly respond to the transmission, decreasing the team's communication efficiency. Communication efficiency can be measured by the number of

messages that were unacknowledged, needed to be repeated, of confused/unclear/questionable value, or exclamatory/excited (Timmons, 2003).

When there is such a great deal of communication between different team members it is important to have closed-loop communication. Closed-loop communication is a process where the sender initiates the message, the receiver accepts and understands the message, providing feedback to the sender to indicate that the message was received and understood, and finally the sender reports back to double check that the intended message was received (McIntyre & Salas, 1995). While this kind of communication may seem excessive in the case of the immediate response of the FDNY, it is still applicable to their communication turns. When the sender does not identify the receiver, or if the intended recipient does not receive the inquiry or piece of information, it results in an increase in communication until the matter is resolved. This repetition of information and requests would decrease if the speaker properly identifies the receiver, the receiver acknowledges that they are listening and ready, the speaker then gives the message, and finally the receiver responds to assure that the message was understood.

There were minor and major SOP deviations in the FDNY communication on September 11, 2001. These deviations were divided into three levels, depending on the severity of their impact.

1. Minor Deviations, SOP Deviation Levels 1 and 2

Minor deviations are on the level of failing to use the necessary “K” after a transmission that warrants a response from the recipient. These errors are labeled a “SOP Deviation #1.” When the sender did not identify themselves and the addressee in their message, it could fail into the “SOP Deviation #1” category or the next level of deviation, “SOP Deviation #2,” depending on the impact of their omission. If the recipient, the Manhattan Dispatcher, had to go out on another radio transmission to ask who the speaker was, and therefore wasted radio time, the deviation is at level #2, but if the deviation was merely in the interest of message brevity it is level #1.

2. Major Deviations, SOP Deviation Level 3

The third level of SOP error is “SOP Deviation #3,” where the repercussions of the SOP error are great, to the level of possibly life threatening. This includes failing to include a “Mayday” or an “Urgent” in the necessary message, or using either phrase in the incorrect message.

a. Urgent Radio Messages

Radio communication on the FDNY radio is classified as either routine or urgent, where urgent messages always have priority. Urgent messages inform others of a serious change in conditions at the scene or that a firefighter has suffered a serious, but not life threatening injury. The five situations where urgent messages apply are as follows:

- a. A firefighter suffers an injury that is not life threatening, but requires medical attention and hospital care
- b. An interior attack on the fire is discontinued and an exterior attack is instituted
- c. Discovery of a structural problem indicating the danger of collapse
- d. Fire is entering an exposure to a degree that any delay may considerably enlarge the fire problem
- e. Loss of water which would endanger firefighters

b. Mayday Radio Messages

Maydays are passed on the radio as an indication that a life-threatening situation has developed. There are only five situations that warrant a mayday:

1. Imminent collapse feared
2. Structural collapse has occurred
3. A firefighter is unconscious or suffers a life threatening injury
4. A firefighter becomes aware that another firefighter is missing
5. A firefighter becomes trapped or lost

E. SITUATIONAL AWARENESS

Situational awareness is crucial to the success of any team. Smith-Jentsch, Johnston, and Payne (2000) used ratings of team situational assessment as a measure of

team performance. Optimally, the team should share situational awareness, ensuring that each team member knows all available information. “Team situational awareness is a consistently good predictor of team performance” (Cooke, Salas, Kiekel, & Bell, 2004, p.101). When situational awareness is lost, individual people, and possibly the entire team, are lost until someone gains enough knowledge to reinstate an accurate awareness. On September 11, 2001, those firefighters in the towers did not have good situational awareness of what was going on outside their immediate surroundings. It is the job of team members on the radios to keep others informed.

When a firefighter simply asks a question of their fellow team members, it is not a loss of situational awareness. Asking questions of your team mates can be a sign of a well formed and functioning team. Losing situational awareness occurs when a team member or the entire team loses their awareness of the situation at hand, to the point where they can no longer act as a functioning, contributing part of the team. Examining examples of where firefighters lost situational awareness and their actions to regain it will show how the team worked together and provide insight into ways to enhance team communication and collaboration.

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VI. RESULTS

A. CODING RESULTS

1. Percentage of Codes

Analysis of the communication turns of the firefighters in the FDNY on September 11, 2001, shows that they used 19 of the 23 cognitive process codes, or 82.61% of the cognitive processes included in the model. The four codes not used were *knowledge object development (ko)*, *individual visualization and representation of meaning (vrm)*, *iterative information collection and analysis (ica)*, and *solution adjustment against goal and exit criteria (sag)*. *Knowledge object development (ko)* and *individual visualization and representation of meaning (vrm)* are not possible on the radio because they include a person using graphics, but they were most probably used in the incident command center in the lobby of the two towers using the command post's board with the location of the fire, operations post, staging area, SAE post, and responding units.¹⁸ These two cognitive processes were definitely used at the dispatcher's office on their map of the location of all responding units. It can be hypothesized that *iterative information collection and analysis (ica)* was not used because firefighters felt compelled to always comment and collaborate towards a solution, not to waste anyone's time on the radio without offering a solution due to the time pressure. *Solution adjustment against goal and exit criteria (sag)* was not used because the firefighters did not think they needed to think about their exit strategy just yet (Zirinsky, et al, 2002).

2. Trends in the Codes

The majority, 849 out of 1620 (52.41%), of the codes were miscellaneous. In the FDNY, these miscellaneous codes correspond to "10-4" and opening a communication channel between the sender and the addressee. Table 1 shows the cognitive codes and their occurrence percentages.

¹⁸ See Chapter II.B.2 for a further discussion of the Incident Command Post and the duties of the other responding chiefs.

Table 1. Cognitive Code Occurrence Percentages.

Code	Cognitive Process	Number	Percentage
Knowledge Construction			
dti	individual conversation of data to information	2	0.12
imm	individual mental model construction	14	0.86
itk	individual task knowledge development	325	20.06
tk	team knowledge development	210	12.96
ko	knowledge object development	0	0.00
vrn	individual visualization and representation of meaning	0	0.00
Collaborative Team Problem Solving			
cu	team integration of individual knowledge for common understanding	16	0.99
kio	knowledge interoperability development	8	0.49
ica	iterative information collection and analysis	0	0.00
tsu	team shared understanding development	6	0.37
sa	develop, rationalize, and visualize solution alternatives	13	0.80
cmm	convergence of individual mental models to team mental models	22	1.36
cs	team agreement on a common solution	1	0.06
Team Consensus			
tn	team negotiation on a common solution	1	0.06
tpr	team pattern recognition	3	0.19
ct	critical thinking	3	0.19
shk	sharing hidden knowledge	5	0.31
sag	solution adjustment against goal and exit criteria	0	0.00
Outcome Evaluation and Revision			
csg	compare solution options against goal	2	0.12
aro	analyze, revise solution options	1	0.06
misc	Miscellaneous	849	52.41
coa	course of action	92	5.68
rta	request to take action	53	3.27
total		1626	

While the miscellaneous codes are important to the communication environment as a whole, because it maintains communication order, keeping the miscellaneous codes in the data analysis distorts the value of the other codes by reducing their percentage of the total. Table 2 shows the cognitive process codes and their revised occurrence percentages when the miscellaneous codes are not included in the totals.

Table 2. Cognitive Code Occurrence Percentages.

Code	Cognitive Process	Number	Percentage
itk	individual task knowledge development	325	42.15
tk	team knowledge development	210	27.24
coa	course of action	92	11.93
rta	request to take action	53	6.87
cmm	convergence of individual mental models to team mental models	22	2.85
cu	team integration of individual knowledge for common understanding	16	2.08
imm	individual mental model construction	14	1.82
sa	develop, rationalize, and visualize solution alternatives	13	1.69
kio	knowledge interoperability development	8	1.04
tsu	team shared understanding development	6	0.78
shk	sharing hidden knowledge	5	0.65
ct	critical thinking	3	0.39
tpr	team pattern recognition	3	0.39
csg	compare solution options against goal	2	0.26
dti	individual conversation of data to information	2	0.26
aro	analyze, revise solution options	1	0.13
tn	team negotiation on a common solution	1	0.13
cs	team agreement on a common solution	1	0.13
ica	iterative information collection and analysis	0	0.00
ko	knowledge object development	0	0.00
vrn	individual visualization and representation of meaning	0	0.00
sag	solution adjustment against goal and exit criteria	0	0.00
Total		777	

a. Implications

Disregarding the miscellaneous codes, *individual task knowledge development (itk)* is the largest category used with 42.15%. This implies that the firefighters are asking a great deal of questions, and while asking questions is encouraged for exchanging team knowledge, it begs the question of whether there is a way to alleviate some of the questions by providing more information to the responding units. This also carries over to the second highest number of codes, *team knowledge development (tk)*, with 210 out of 771 (27.24%). This indicates that the team is sharing knowledge among members, without being asked.

Much of the radio communication revolves around asking fellow firefighters to respond or do something towards the team's goal. This is seen in the next two codes, *course of action* (*coa*, 11.93%) and *request to take action* (*rta*, 6.87%). These codes show the firefighters taking actions towards their end goals, with the knowledge that they do not have to carry out the plan of action themselves; they can ask for support from their fellow responders.

The remaining cognitive process codes with smaller percentages of use show that the FDNY did not reach the later stages included in the Structural Model of Team Collaboration (Figure 1, pp. 4). The best example of this is that the FDNY did not reach the *solution adjustment to fit goals and exit criteria* because they did not foresee that they would need to worry about their exit strategy so early in their rescue mission. Most of their efforts were aimed at trying to figure out what was going on around them, creating a mental model which required gathering knowledge and information.

3. Individual Cognitive Processes Progressing to Team Cognitive Processes

Analyzing the individual communication turns of the individual firefighters helps illuminate the cognitive processes that support their individual decisionmaking. Together these processes combine to represent the team's cognitive processes which lead to the team's mental model, and ultimately the team's decisionmaking.

a. Shared Understanding

Table 3 depicts the team's progression toward development of a team shared understanding of where the staging area was at the scene. The staging area discussed by "Brooklyn" on the radio was a staging for those units coming into Manhattan from Brooklyn waiting for their further assignments from the Manhattan dispatcher.

Table 3. Excerpt from FDNY Communications: Coding for Developing Team Shared Understanding (Time: 8:52 am).

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
1	FIELD	Brooklyn to Manhattan.	misc	
2	DISPATCH	Brooklyn, go.	misc	
3	FIELD	On the [inaudible] for your information Brooklyn is transmitting a box at the Brooklyn end of the Battery Tunnel. We will use this as a staging area for apparatus to respond to Manhattan.	tk ct	<i>Team knowledge development:</i> team members clarify information to build team knowledge <i>Critical thinking:</i> team members working together toward a common goal, exchanging ideas and judgment, and considering evidence, counterevidence, and context.
4	DISPATCH	Ten-four.	misc	Acknowledgement of message.

Firefighters in the field set up the staging area and had to relay that information back to the Manhattan dispatcher, so that the dispatcher in turn could relay the information out to the other reporting firefighters. Setting up the staging area to collect and organize resources requires judgment and consideration for direct ease of access for incoming firefighters and firefighters going to the scene. The staging area needs to be far enough away from the scene so the resting and waiting firefighters and resources do not get in the way of those at the attack, but close enough so that they can provide relief in a short amount of time. It can be assumed that this level of consideration went on “behind the scenes” and off the radio waves between those firefighters represented by “Brooklyn” to the Manhattan dispatcher in Table 3. Before they suggested a staging area there was *critical thinking (ct)* before they reached a consensus for the “common goal” of providing a location for the staging area.

Division 1 provides knowledge about the staging area at the scene of the WTC site in Table 4.

Table 4. Excerpt from FDNY Communications: Coding for Developing Team Shared Understanding (Time: 8:53 am).

FDNY Communications			Cognitive Process Coding	
	Speaker		Code	
1	FIELD	Division 1 to Manhattan	misc	
2	FIELD	The staging area at the fire scene here is beyond West Street. All units respond into West Street. Transmit a 10-60 also. ¹⁹	kio coa	<i>Knowledge interoperability</i> : team members exchanging knowledge among each other. <i>Issue order regarding a course of action</i> : a superior in the chain of command tells a team member to take a specific action against a possible threat attack.
3	DISPATCH	All right, 10-60's been transmitted, box 8087, 10-60, box 80-87 for 1 World Trade Center. All units responding into box 8087, the staging area will be at West Street, K.	tk tsu	<i>Team knowledge development</i> : team member clarify information to build team knowledge <i>Team shared understanding</i> : discussion among all team members on a particular topic or data item.

This staging area is for units already assigned to the scene, waiting for assignment to one of the posts (operations, staging, or SAE²⁰) in the attack. Since Division 1 is at the scene, they can relay an order for all units responding to report to West Street. When the Manhattan dispatcher transmits out on the radio that the staging area at the scene of the WTC is on West Street and alerts the incoming firefighters of a 10-60 it provides team shared understanding of the problem at hand.

b. Critical Thinking

For the full description of *critical thinking*, *ct*, see Appendix A, Table 27. Critical thinking requires: an active exchange of ideas, self-regulatory judgment, and

¹⁹ Transmitting a “10-60” means the scene requires a “Major Emergency Response,” where there is a high risk of multiple casualties (Communication Manual, 1998).

²⁰ See Chapter II.B.2 for descriptions of these posts.

systematic consideration of evidence, counterevidence, and context. (Hess & Freeman, 2004, in Warner, Letsky, & Cowen, 2004). It is a composite of

- MCitk: *individual task knowledge development* = **individual team member clarifying data; asking for clarification.**
- MetCcu: *team integration of individual knowledge for common understanding* = **one or more team members combine individual pieces of knowledge to achieve a common understanding.**
- MCKio: *knowledge interoperability* = **team members exchanging knowledge among each other.**
- MCSa: *develop, rationalize and visualize solution alternatives* = **using data to justify a solution**

(Warner & Wroblewski, 2004; Hess & Freeman, 2004)

Thus, *critical thinking* is one MCitk, one MetCcu, one MCKio, and one MCSa. It is difficult to ensure that all requirements are fulfilled in labeling a communication turn as a *ct* when not all of the team's communication was transmitted on the radio frequency, and therefore, not all recorded for analysis.

Two out of the three communication turns labeled as *critical thinking* discussed the location of injured people. The other *ct* communication turn was in reference to the location of the staging area. Radio communication pertaining to these issues warranted communication "off line," that was not discussed on the Manhattan dispatcher's frequency. The only thing the other responding units on the Manhattan dispatcher frequency needed to know was the location of the staging area and the location of those injured. Therefore, the necessary *itk*, *cu*, *kio*, and *sa* are not directly labeled in the transcript codings because they happened between the firefighters at the scene, not using the radio.

B. INTER-RATER RELIABILITY ANALYSIS

Having two people code the FDNY radio communication for team collaboration tested the potential for subjectivity of coders when applying the definitions for the

cognitive processes included in the model. Between the two coders there were 34 (4.37%) disagreements in codes (seen in Table 28, Appendix C), based on a total of 1626 speech turns, and 49 (6.31%) codes decided upon after a discussion between the coders (seen in Table 29, Appendix C); thus in total the coders agreed on 89.32% of codes. When the coders disagreed, the two discussed their differing opinions to reach an agreement on their coding. When a code was decided upon after a discussion it was because one or both of the coders was unsure of how to code the communication turn and thus left it to discuss further with the other coder.

Almost half (42 out of 87, 48.28%) of the coding discussions were between the use of *team knowledge development (tk)* and another code (seen in Table 30, Appendix C). Out of these disagreements or discussions, the coders decided to use some other code other than *tk* 35 times (83.3%) (seen in Table 31, Appendix C). The coder that brought the other code to the table was usually the one that wanted to discuss the code and was able to convince the other coder to deviate from the *tk* code. This could represent a tendency of the coders to code away from *tk* because it is such a highly used code. It is important to keep all the definitions in mind and not rely on the seemingly easier codes like *itk* and *tk*.

C. COGNITIVE PHASES

A team must have a mental model within which they are making their decision. In the case of the FDNY on September 11, 2001, there were events that occurred that morning which changed their working mental model. First there was only one plane that flew into the North Tower, and then there was a second plane that flew into the South Tower. Still, within this mental model it was not deemed possible that the buildings would collapse. Then, the South Tower collapsed, followed by the collapse of the North Tower. The communication transcripts are divided into phases that correspond to these four major events which caused the FDNY's working mental model to change with each new major event.

Looking at the attack on the WTC on September 11, 2001, as one large problem, the FDNY never reached the ultimate *outcome evaluation and revision stage* included in

the Structural Model of Team Collaboration. To see the full effect of the collaboration stages and cognitive processes at work in the FDNY on September 11, 2001, the larger problem of search and rescue and extinguishing the fire should be broken into smaller problems. Each of the smaller problems represents a smaller version of the collaboration stages and cognitive processes depicted in the flow chart in Figure 3. Even though they do not flow through all of the stages, breaking down the larger problem shows the cognitive development better than the larger problem as a whole.

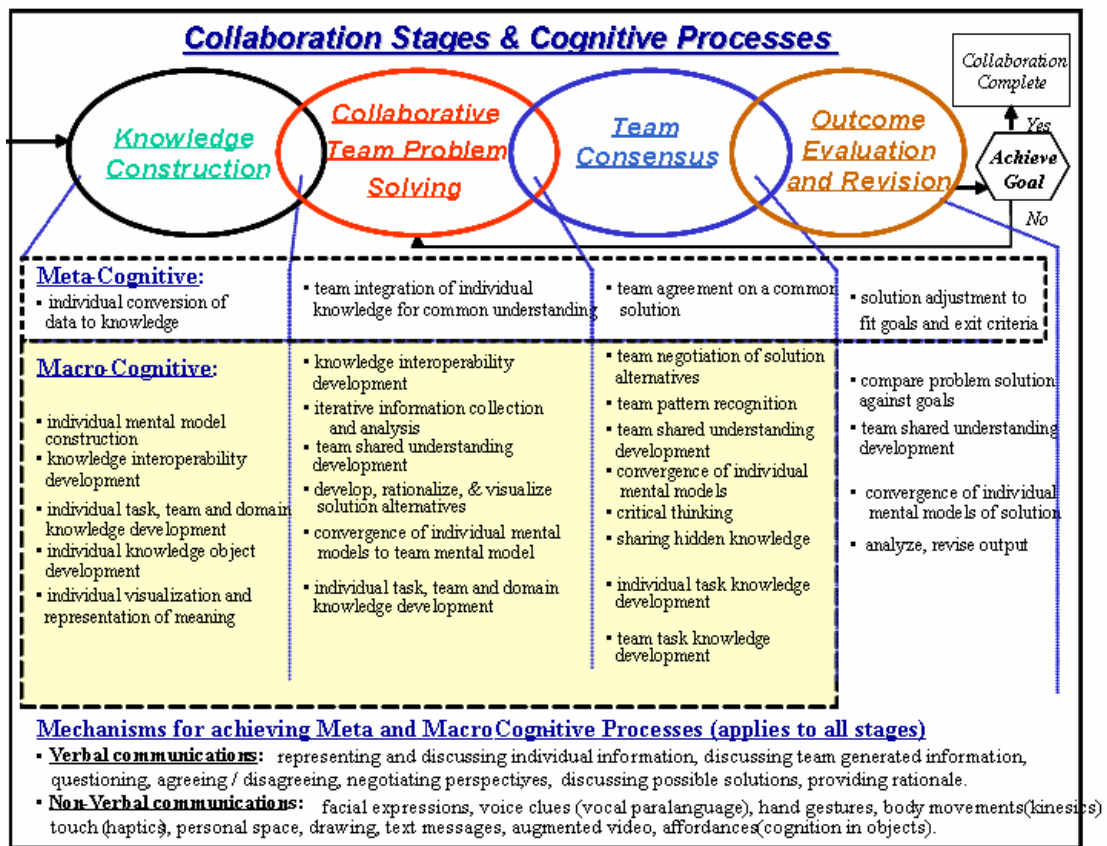


Figure 3. The Structural Model of Team Collaboration Flow Chart (Warner, Letsky, & Cowen, 2004).

1. The First Cognitive Phase

The first phase of the transcripts to be analyzed involved the time period from 8:46 am to 9:02 am. At 8:46 am the first plane flew into the North Tower of the World Trade Center, and Battalion 1 notified the Manhattan dispatcher over the radio. In these first 17 minutes the FDNY was battling a fire caused by one plane that flew into one

building. As evidenced by the fact that an evacuation of the South Tower was not ordered for ten minutes after the North Tower was hit, and once given over the public address system at 9:02 am (less than one minute before the plane hit the building), the announcement told civilians to evacuate in an orderly fashion, if conditions warranted. Furthermore, this evacuation was only ordered because it was thought that the second building was unsafe due to the impact of the first building, not because authorities thought the South Tower was threatened as well (National Commission on Terrorist Attacks, 2004). The idea that the plane was a terrorist attack was considered a possibility, but certainly not a probability in the minds of the firefighters. This first phase of collaboration involved gaining knowledge about the situation at hand. This changed at 9:02 am, when a second plane flew into the South Tower of the WTC.

a. The Initial Mental Model

The first problem was figuring out what had happened and creating a mental model within which to work. At 8:46 am Battalion 1 called the Manhattan dispatcher to report the crash (*sharing team knowledge, tk*) and to request a second alarm, providing more units at the scene (*course of action, coa*), seen in Table 5.

Table 5. Excerpt from FDNY Communications: Reporting the crash (Time: 8:46 – 8:47 am).

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
1	FIELD	Battalion 1 to Manhattan	misc	
2	DISPATCH	Battalion 1.	misc	
3	FIELD	We just had a plane crash into upper floors of the World Trade Center. Transmit a second alarm and start relocating companies into the area.	tk coa	<i>Team knowledge development: team members clarify information to build team knowledge</i> <i>Issue order regarding a course of action: a superior in the chain of command tells a team member to take a specific action against a possible</i>
4	DISPATCH	Ten-four, Battalion 1.	misc	Acknowledgement of the message.
5	FIELD	Battalion 1 is also sending the whole	tk	<i>Team knowledge development: team members clarify information to build</i>

FDNY Communications			Cognitive Process Coding	
Speaker			Code	
		assignment on this box to that area.		team knowledge

As more units called in to report the crash (various *tk(s)*), the dispatcher was able to form a mental model. Relaying knowledge back to the dispatcher is key, as they are not located at the scene of the attack; anything the dispatcher knows comes from field reports from the firefighters. Once on site, it became clear to the firefighters that the crash might have been an intentional terror attack (*individual mental model construction, imm*). This in turn changed the team's mental model (*convergence of individual mental models to a team mental model, cmm*). This progression can be seen in Table 6.

Table 6. Excerpt from FDNY Communications: Possibility of a Terror Attack (Time: 8:47 am).

FDNY Communications			Cognitive Process Coding	
Speaker			Code	
1	FIELD	Squad 1-8 to Manhattan, K.	misc	
2	DISPATCH	Squad 1-8, K.	misc	
3	FIELD	It looked like it was intentional. Inform all units coming in from the back it could be a terror attack.	imm	<i>Individual mental model construction</i> : individual team member develops a mental picture of problem situation
4	DISPATCH	Ten-four. All units be advised.	cmm	<i>Convergence of individual mental models to team mental model</i> : convincing other team members to accept specific data, information or knowledge

Looking at the firefighters' collaborative decisionmaking progressing through the stages in the model, in a matter of minutes the FDNY moved through the *knowledge construction and collaborative team problem solving stage* into the *team consensus and outcome evaluation and revision stage* (see Figure 3) as the team of firefighters agreed that more units were needed to save the many civilians trapped inside

the buildings. Their speed of collecting information and making decisions saved countless lives in the various buildings at the WTC complex. Moving into the *outcome evaluation and revision stage*, they called for third and fourth alarms. Furthermore, when the second plane hit the South Tower, they had to further reevaluate their solution, calling for a fifth alarm.

2. The Second Cognitive Phase

The second phase of the team's collaboration is from 9:02 am to 9:58 am. At 9:02 am, when a second plane flew into the South Tower, the FDNY had to divide their resources between the two towers. The second plane also led to the conclusion that this was in fact an intentional terrorist attack. While it was within the realm of possibility that buildings partially collapse, it was not within the mental model of the firefighters of the FDNY team's mental model that there would be a complete collapse. The firefighters knew rescuing all of the civilians in the towers was a large problem, but they thought they had a large span of time in which to do it. When the South Tower completely collapsed at 9:58 am, it changed the mental model of the team's thinking to one where there was a finite amount of time to fight the fire. Now they needed to focus on the problem of evacuating rescue workers from the North Tower.

a. The South Tower Collapses and Changes the Mental Model

The firefighters were acting according to their SOP when making their way up to the fire and to the trapped civilians. They knew this incident was occurring on a much larger scale than anything they had fought before, but they believed it was still within their grasp to accomplish their goals of extinguishing the fire and evacuating as many civilians as possible.

Table 7 shows the progression from the firefighters' individual mental models to the team's mental model after the collapse.

Table 7. Excerpt from FDNY Communications: Coding for Developing a Team Mental Model (Time: 9:58 am – 9:59 am)

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
1	FIELD	... to Manhattan, urgent.	misc	
2	DISPATCH	Go ahead, K.	misc	
3	FIELD	One of the buildings, the entire building has collapsed...	imm	<i>Individual mental model construction:</i> individual team member develops a mental picture of problem situation
4	DISPATCH	... urgent identify	itk	<i>Individual task knowledge development:</i> individual team member clarifying data, asking for clarification.
5	FIELD	... major collapse in one of the towers	imm	<i>Individual mental model construction:</i> individual team member develops a mental picture of problem situation
6	DISPATCH	Which tower, K?	itk	<i>Individual task knowledge development:</i> individual team member clarifying data, asking for clarification.
7	FIELD	Tower 2, Tower 2.	itk	<i>Individual task knowledge development:</i> individual team member clarifying data, asking for clarification.
8	FIELD	The entire tower, major collapse.	tk	<i>Team knowledge development:</i> team members clarify information to build team knowledge
9	DISPATCH	Ten-four.	misc	Acknowledgement of message.
10	FIELD	Marine 6 to Manhattan, urgent.	misc	
11	DISPATCH	Marine 6.	misc	
12	FIELD	Tower 2 has had a major explosion and what appears to be a complete collapse surrounding the entire area.	imm	<i>Individual mental model construction:</i> individual team member develops a mental picture of problem situation
13	DISPATCH	Marine 6, 10-4. We were notified, K.	cmm	<i>Convergence of individual mental models to team mental</i>

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
				<i>model</i> : convincing other team members to accept specific data, information or knowledge

Communication between the dispatcher and the field shows the integration of an individual mental model leading to team knowledge and ultimately to an altered team mental model. There was a quick flow from the *knowledge construction phase* to the *collaborative team problem solving phase*, leading to the *team consensus phase* and to the *outcome evaluation and revision phase* because the FDNY officials had to immediately alter their course of action, since now the towers could collapse. Marine units²¹ were especially valuable on September 11, 2001, because they were able to provide information from afar. The Marine units were stationed in New York harbor so their view of the scene was not distorted by the enormous smoke cloud that covered lower Manhattan after the collapse of the South Tower. The dispatcher's response to Marine 6 in line 13 of Table 7 that "we were notified" shows the change in the team's mental model as the dispatcher assures Marine 6 that they were already working within a new framework.

3. The Third Cognitive Phase

The third phase occurred from 9:58 am to 10:28 am. The South Tower collapsed at 9:58 am, only 56 minutes after the plane flew into the building. The enormous cloud of dust that came from the South Tower's collapse left many without situational awareness regarding the state of Lower Manhattan. When the South Tower collapsed, the Incident Command Post in the lobby was lost, killing many high ranking firefighters. The FDNY had to recreate their chain of command and assign a new Incident Command Post, outside of the North Tower, lest it collapse as well. At 10:28 am, the North Tower collapsed; an hour and 41 minutes after the plane flew into the building. The FDNY's team mental model during this time was one of chaos.

²¹ Marine units in the FDNY are units that are on the water. They usually respond to pier or ship fires, and can also offer support to land fires by supplying water.

4. The Fourth Cognitive Phase

The final, and fourth, phase occurred from 10:28 am until 11:07 am. This time period includes the time between when the North Tower collapsed until the end of that radio transmission tape recording. This period of time is similar to that of the previous phase (approximately a half hour), but this time both buildings were completely gone. This added an element of shock and grief, knowing that many firefighters were dead, trapped, or lost.

D. CHI SQUARE ANALYSIS OF DIFFERENCES IN PERCENTAGE USAGE OF THE COGNITIVE CATEGORIES

A Chi Square analysis was performed to examine differences in the percentages of usage of the cognitive processes codes. The Chi Square analyses were done two different ways:

1. All 23 cognitive codes between all four phases of the model
2. All 23 cognitive codes compared between two of the phases of the model

Each time, the null hypothesis was that there would be no difference in the usage of cognitive processes between the phases of the model, and the alternate hypothesis was that there would be a difference in the usage of cognitive processes between the phases of the model. The complete results can be found in Appendix D.

The observed values for the cognitive process codes are the same across all of the four phases, found in Table 32 of Appendix D. The expected values are calculated from these observed values by:

$$\frac{N_{cog}}{N_{total}} \times N_{phase}$$

Where N_{cog} is the total number of communication turns coded as that cognitive process, N_{total} is the total number of communication turns, and N_{phase} is the total number of communication turns in that cognitive phase.

The Chi Square value is calculated by:

$$\frac{(Observed - Expected)^2}{Expected}$$

When comparing between two cognitive phases, *knowledge object development (ko)*, *individual visualization and representation of meaning (vro)*, *iterative information collection and analysis (ica)*, and *solution adjustment against goal and exit criteria (sag)* were eliminated from the analysis because they were not used.

When all 23 cognitive codes were compared across the four phases of the model, the Chi Square value was 124.9597 (Table 34, Appendix D), clearly surpassing the p-values for all values of alpha (Table 35, Appendix D). This concludes that there was a difference in the team's use of the cognitive processes in the four phases of the model.

When comparing all 23 cognitive codes across the cognitive categories two by two, there were statistically significant differences between categories one and two, one and four, and two and four, as seen in Table 8.

Table 8. Summary of the Chi Square Analysis for all 23 Cognitive Categories Between Two Categories.

Category	Category	P-value	Alpha for Significance
1	2	47.8053	0.001
1	3	22.5841	none
1	4	30.3481	0.05
2	3	26.407	none
2	4	40.568	0.01
3	4	20.945	none

Comparison of the 23 codes across two of the cognitive categories showed there were statistically significant differences in the individual codes across the cognitive categories as well. These differences can be seen in Table 9.

Table 9. Summary of the Chi Square Analysis for the Differences in Individual Codes That Were Statistically Significant Between Two Categories.

Category	Category	Cognitive Code	p value	Alpha for Significance
1	2	imm	10.1701	0.01
1	2	itk	12.9641	0.001
1	2	tsu	11.3067	0.001
1	3	cu	4.067	0.05
1	3	tsu	5.42	0.05
1	4	itk	10.8771	0.001
2	3	imm	5.1687	0.05
2	3	kio	6.2557	0.05
2	4	tk	4.1844	0.05
2	4	kio	5.53	0.05
2	4	shk	6.913	0.05
3	4	cu	5.3043	0.05

A simple Chi Square analysis alone does not demonstrate how data are different, only indicates that there is a difference. To show where the differences are, requires looking at the square root of the Chi Square values. The most significant differences (between categories one and two, and categories one and four) were chosen for further investigation of the coding differences. These are seen in Table 10.

Table 10. Summary of the Chi Square Analysis for Differences in Individual Codes That Were Statistically Significant Between Two Categories.

Categories	Cognitive Code	Category	Chi Square Values	Square Root of Chi Square Values
1 & 2	imm	1	7.5124	2.7409
		2	2.6577	1.6302
1 & 2	itk	1	9.5762	3.0945
		2	3.3878	1.8406
1 & 2	tsu	1	8.3520	2.8900
		2	2.9547	1.7189
1 & 4	itk	1	7.3043	2.7027
		4	3.5728	1.8902

Significant differences in their chi square values carry over into the square root of these chi square values. Looking at these differences it is easy to see which category is at “fault” for causing such a high total chi square value, pushing the value beyond the alpha value.

Differences in the Chi Square values between the first and second cognitive categories across all three cognitive process codes are attributed to the first cognitive category. It is understandable that the first cognitive category would be responsible for differences between *individual mental model construction (imm)*, *individual task knowledge development (itk)*, and the *team shared understanding (tsu)* because the firefighters are asking questions trying to create an understanding of the situation to develop the team’s mental model of the fire.

Difference in the Chi Square values for *individual task knowledge development (itk)* between the first and fourth cognitive categories are also attributed to the first category. Again, this shows that the situation during the first period of the attack, where firefighters are first arriving at the scene, warranted more questions than the final period, where firefighters are trying to find the wounded and trapped.

E. OTHER PROBLEMS REQUIRING TEAM COLLABORATION

1. The Traffic Mental Model

Traffic into and out of Manhattan was a big problem for responders on September 11, 2001. Between emergency responders, media, and civilians trying to leave the island of Manhattan either by foot, car, or mass transit, traffic was nearly impossible. Relaying information about the fastest routes via tunnels and bridges was crucial to getting more resources to the scene. This specific example (in Table 11) shows a greater level of collaboration because it incorporates the report from Engine 228 that the dust cloud has dissipated and cleared the Brooklyn-Battery Tunnel for use.

Table 11. Excerpt from FDNY Communications: Coding for Sharing Information for the Traffic Flow Mental Model (Time: 10:14 am – 10:15 am).

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
1	FIELD	Engine 2-2-8 to Manhattan, K.	misc	
2	DISPATCH	Engine 2-2-8.	misc	
3	FIELD	Would you inform the units... they were inspecting the Brooklyn-Battery Tunnel, the first cloud has subsided and the units can come through the tunnel now... to proceed, K. Are there any further instructions for Engine 2-2-8 at this time?	coa sa itk	<i>Issue order regarding a course of action:</i> a superior in the chain of command tells a team member to take a specific action against a possible threat attack. <i>Develop, rationalize and visualize solution alternatives:</i> team member uses data to justify a solution <i>Individual task knowledge development:</i> individual team member clarifying data, asking for clarification.
4	DISPATCH	Engine 2-2-8, at this time respond in to the command post West Street and Albany Street. Standby for instructions over there.	rta	<i>Request take action:</i> team member requests another team member to take some action.
5	FIELD	Engine 2-2-8, 10-4. Just put on the Manhattan frequency for the other units responding to the location that they can proceed through the tunnel, dust cloud on the Manhattan side has subsided, K.	sa	<i>Develop, rationalize and visualize solution alternatives:</i> team member uses data to justify a solution
6	DISPATCH	Attention all companies responding to West Street and Albany Street for the second alarm, the Brooklyn-	tk	<i>Team knowledge development:</i> team members clarify information to build team knowledge

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
		Battery Tunnel is now open. The dust cloud has dissipated.	cmm	<i>Convergence of individual mental models to team mental model</i> : convincing other team members to accept specific data, information or knowledge
		All units can respond in to West Street and Albany Street for the second alarm for box 5-0. The dust cloud has subsided for the Brooklyn-Battery Tunnel.	tk	<i>Team knowledge development</i> : team members clarify information to build team knowledge

The Brooklyn-Battery Tunnel provided a *solution alternative (sa)* to the problem of traffic flow into Manhattan. Not only did Engine 228 inform the dispatcher of the availability of the Brooklyn-Battery Tunnel, they also specifically requested that the dispatcher pass the information to the entire Manhattan frequency, knowing how important that information was to the flow of traffic to support the emergency response in lower Manhattan. When that information went out to the entire frequency it created a new team mental model for those traveling in the area in line 6 of Table 11 (*convergence of individual mental models to team mental model, cmm*).

Ladder 14 also contributed to the traffic mental model, providing a report that Seventh Avenue was “wide open” (Table 12). Again, when the dispatcher transmitted to the entire frequency that Seventh Avenue was open it added another piece of information to the team’s mental model.

Table 12. Excerpt from FDNY Communications: Coding for Sharing Information for the Traffic Flow Mental Model (Time: 10:15 am).

FDNY Communications			Cognitive Process Coding	
	Speaker		Code	
1	FIELD	One-four to Manhattan	misc	
2	DISPATCH	One-four.	misc	
3	FIELD	For responding companies, Seventh Avenue is wide open, clear.	tk	<i>Team knowledge development: TMs clarify information to build team knowledge</i>
4	DISPATCH	Seventh Avenue is wide open?	itk	<i>Individual task knowledge development: individual team member clarifying data, asking for clarification.</i>
5	FIELD	Ten-four.	itk	<i>Individual task knowledge development: individual team member clarifying data, asking for clarification.</i>
6	DISPATCH	Ten-four. All units going in to the World Trade Center, be advised, Ladder 1-4 reports Seventh Avenue is wide open and also West Side Highway is open. All units going into the fifth alarm, West Side Highway is open and Seventh Avenue is open at the time per Ladder 1-4.	cmm	<i>Convergence of individual mental models to team mental model: convincing other team members to accept specific data, information or knowledge</i>

For the Queens units responding to the WTC Car 5 informed the dispatcher that the Port Authority opened the bus lane in the Midtown Tunnel for emergency traffic (see Table 13).

Table 13. Excerpt from FDNY Communications: Coding for Sharing Information for the Traffic Flow Mental Model (Time: 10:16 am).

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
1	FIELD	Car 5 to Manhattan	misc	
2	DISPATCH	Manhattan responding.	misc	
3	FIELD	Advise the Queens unit that the bus lane heading into the Midtown Tunnel is wide open, the Port Authority has it all open for us both ways.	sa	<i>Develop, rationalize and visualize solution alternatives:</i> team member uses data to justify a solution
4	DISPATCH	Ten-four. Attention all companies responding into Manhattan from the Queens side, Midtown Tunnel bus lane is wide open. All units responding into Manhattan from Queens, Midtown Tunnel bus lane is wide open.	sa	<i>Develop, rationalize and visualize solution alternatives:</i> team member uses data to justify a solution

In the two minutes represented by Tables 11 through 13 firefighters combined their individual knowledge to provide additional information to their traffic mental model of Manhattan.

2. Assigning a New Staging Area

After both the North and the South Towers collapsed, the firefighters in command had to find a new staging area near the WTC. As previously noted, the location of a staging area is a key component of an emergency response. Division 6 told the Manhattan dispatcher that the new staging area was located at Broadway and Vescey Streets, and the dispatcher, in turn, relayed this information to the incoming reporting units, seen in Table 14.

Table 14. Excerpt from FDNY Communications: Coding for Developing a Team Mental Model About the New Staging Areas (Time: 11:04 am)

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
1	FIELD	Division 6, we have a command post set up on Broadway and Vescey Street, K.	tk	<i>team knowledge</i> development: team members clarify information to build team knowledge
2	DISPATCH	All right, Division 6, be advised there's a full third alarm assignment sitting in Brooklyn. Do you want them to report to Broadway and Vescey?	itk	<i>Individual task knowledge</i> development: individual team member clarifying data, asking for clarification.
3	FIELD	[inaudible]		
4	DISPATCH	All right. They're actually on the Manhattan side of the Brooklyn Bridge. If you need them let us know.	tk	<i>team knowledge</i> development: team members clarify information to build team knowledge
5	FIELD	Division 6 to Manhattan, absolutely. Send them to Broadway and Vescey right all Park Row.	coa	<i>issue order regarding a course of action</i> : a superior in the chain of command tells a team member to take a specific action against a possible threat attack.
6	DISPATCH	All right, 10-4.	misc	Acknowledgement of message.
7	DISPATCH	All units who are responding to the staging area at the Brooklyn Bridge are to report in to Broadway and Vescey Streets, Broadway and Vescey Streets.	coa cu	<i>issue order regarding a course of action</i> : a superior in the chain of command tells a team member to take a specific action against a possible threat attack. <i>team integration of individual knowledge for common understanding</i> : all team members combine individual pieces of knowledge to achieve a common understanding.

Immediately following this order, Battalion 42 asks for clarification due to conflicting orders. It showed *individual task knowledge development (itk)* when Battalion 42 was unsure as to where they should respond (Table 15).

Table 15. Excerpt from FDNY Communications: Coding for Developing a Team Mental Model about the New Staging Areas (Time: 11:04 am – 11:05 am).

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
1	FIELD	Four-two Battalion to Manhattan	misc	
2	DISPATCH	Four-two Battalion.	misc	
3	FIELD	Four-two Battalion has the third alarm assignment right now on Chambers between Church and the bridge. You're redirecting us?	tsu	<i>Team shared understanding: discussion among all team members on a particular topic or data item.</i>
4	DISPATCH	Four-two Battalion, I want you to take that whole third alarm to Broadway and Vescey, hook up with Division 6 acting Division 1. He will give you further instructions.	tsu	<i>Team shared understanding: discussion among all team members on a particular topic or data item.</i>

Instead of merely going with what they were told previously and ignoring the current order, or ignoring their previous order and reporting to the new staging area, Battalion 42 clarified with the Manhattan dispatcher before proceeding.

3. Pushing and Pulling Required Information

All FDNY units are required to have a firefighter monitoring the radio at all times. This ensures that all units will respond if addressed and keeps all units aware of the location and actions of the other responding units. In a high performing team, members know when to push and pull information from their fellow teammates²². When

²² For further discussion about pushing and pulling information see Chapter III.A.2.

monitoring the radio, a firefighter should know when to supply information specific to his unit. Table 16 provides an example of pushing corrected information.

Table 16. Excerpt from FDNY Communications: Providing Necessary Information to Team without being asked (Time: 9:02 am).

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
1	FIELD	Can you confirm that Hazmat 1 is responding to the 10-60?	itk	<i>Individual task knowledge</i> development: individual team member clarifying data, asking for clarification.
2	DISPATCH	They've been assigned, K.	itk	<i>Individual task knowledge</i> development: individual team member clarifying data, asking for clarification.
3	FIELD	Hazmat1 to Manhattan.	misc	
4	DISPATCH	Hazmat 1.	misc	
5	FIELD	We are responding. We're just out of the tunnel.	tk	<i>Team knowledge</i> development: team members clarify information to build team knowledge

The Manhattan Dispatcher was unable to provide the exact information requested by the responding unit in the field, requesting the whereabouts of Hazmat 1. The radio operator at Hazmat 1 was able to provide that information to the responding field unit because they were properly monitoring the radio.

At 9:03, when Marine 6 reported “a second plane into the other tower” the Manhattan dispatcher relayed the information as “a second plane into the World Trade Center,” which instead could have been interpreted as a second plane into the North Tower or any other one of the buildings in the WTC complex. Marine 6 pushed information to correct the Manhattan dispatcher’s message, saying, “that’s the other tower,” to which the dispatcher corrected the message to say, “That’s the second tower at the World Trade Center, K.” Members of a high performing team know when to provide “back-up behavior” to their fellow team mates, either in the form of knowledge or

providing physical back up. This team member interaction makes the team greater than the sum of the individual parts (McIntyre & Salas, 1995).

F. LOSS OF SITUATIONAL AWARENESS

While there were certainly times throughout the morning of September 11, 2001, where situational awareness was completely lost, as it was after the second plane hit the South Tower, and when the South and North Towers collapsed, there are also minor losses of Situational Awareness that combined together hinder the overall Situational Awareness of the team.²³

1. Minor Losses of Situational Awareness

Minor setbacks in Situational Awareness usually came in the form of vague and/or inaccurate information. This was quite common when firefighters reported floor numbers. Since the buildings were so large, it was very difficult to tell where the impact zone was, which floors were on fire, and which floors just had smoke without getting a report directly from those on the floors. This carried over when firefighters unfamiliar with the area did not know which building was the “North” Tower or “South” Tower, or which was WTC 1 and WTC 2.²⁴ During the rescue phase, after both towers collapsed this was a problem because people did not know under which tower they were caught.

Hindsight enables analysis to investigate incorrect information passed on the radio. For example, at 9:04 am, Marine 6 reports to the Manhattan dispatcher that the plane in the South Tower of the WTC was, “a large bomber-style green aircraft.” Knowing that the plane into the South Tower was in fact a passenger jet, this information is incorrect. While it is impossible to know the implications from passing this piece of incorrect information, there were other units outside the WTC that could have corrected this information if they saw the plane hit the building.

²³ A complete table with the losses of Situational Awareness can be found in Appendix E.

²⁴ The North Tower is WTC 1 and the South Tower is WTC 2.

2. Major Losses of Situational Awareness

Minor losses of Situational Awareness can quickly turn into a more major loss when the vague information cannot identify the location of a problem. For example, there was a report through Engine 317 from the PAPD that the elevators on the 44th floor were about to come down. When the dispatcher asked to clarify which building it was, Engine 317 was unsure, and said to go with both. The dispatcher then went out with a message to all responding companies that the elevators in both buildings were about to come down. The firefighters working in whichever building the elevator was not coming down would have had continued access to this elevator, but instead were told not to use them because of vague information.

At 9:13 am, the dispatcher confused the Mobile Command Vehicle and the Field Communications Unit (Field Comm). Car 9 asked the dispatcher to find out the Mobile Command Vehicle's estimated time of arrival (ETA) and the dispatcher went out to Field Comm instead. Car 9 came back on the radio to correct this error, but seemingly minor errors such as this could have escalated much further if Car 9 had not caught the confusion.

The largest loss of Situational Awareness was after the South Tower collapsed. While it was clear to those away from the site who had a visual on the towers that it was an entire collapse, for those at the WTC it was unclear as to whether it was a partial or total collapse. Situational Awareness was even worse for the Manhattan dispatcher because while they were removed from the scene, they did not have a visual, so they were completely reliant upon the reports from others. The dispatcher repeatedly asked for any units in the area around the WTC to report back with an account of the state of the WTC so they could send the necessary support units to the scene.

It was also very difficult to know who had survived the collapse. The collapse of the South Tower destroyed the FDNY's on scene accountability system, a magnetic board located in the command center across the street from the South Tower on West Street, which was destroyed by the collapse (Hough, 2007). This was especially apparent by the efforts the Manhattan dispatcher had to take to try to find Field Comm. One report

over the radio from a firefighter at the site was, “Everybody in the area had to run. I don’t know if Field Comm. is available.” The dispatcher had to continually ask for any unit in the collapse area to give them a report on the scene. Field Comm. was lost in the collapse of the South Tower, but no one could give the dispatcher a confirmation that this was the case, so the dispatcher had to continually ask for reports and attempted to find Field Comm. The Manhattan dispatcher did have contact with the Mobile Command Vehicle, which is similar to Field Comm²⁵.

Before the North Tower collapsed, the dispatcher still did not have a full grasp of what was going on at the scene of the WTC. After the collapse, situational awareness continued to get worse. Now it was impossible to say where responders were between the new and old staging areas, command centers, or triage areas. Following the collapse of the North Tower, the dispatcher requested a response from “any division or any staff chief at the scene of the World Trade Center.” To give a picture of the situation, the Mobile Command Vehicle responded saying, “Negative on any Chief, K. Right now we’re all alone. The second building came down. I can’t see. So we have no contact with anybody at this time, K.” This shows the level of confusion, not only due to a loss of command, but also a loss of the ability to see people and objects, resulting in disorientation.

Just before 11:00 am many calls came in from people trapped in the rubble of both towers. Their Situational Awareness was very low, as they were lost, and this confusion carried over to the Manhattan dispatcher, since they had difficulty relaying their location. This made it difficult for the dispatcher to properly assign responders to their position to help them.

G. COLLABORATING TO MAINTAIN SITUATIONAL AWARENESS

After the plane flew into South Tower of the WTC at 9:02 am there were many radio transmissions informing the Manhattan dispatcher of the second attack. Table 17 provides an example of the FDNY working together to maintain team situational awareness.

²⁵ See Chapter V.B.4 for a further description of Field Comm and the Mobile Command Vehicle.

Table 17. Excerpt from FDNY Communications: Maintaining Team Situational Awareness After the Plane Flew into the South Tower (Time: 9:02 - 9:03 am).

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
1	FIELD	Marine 6 to Manhattan urgent.	misc	
2	FIELD	You have a second plane into the other tower of the Trade Center, major fire.	tk	<i>Team knowledge</i> development: team members clarify information to build team knowledge
3	DISPATCH	Car 4 David, Marine 6 advising a second plane into the World Trade Center, K.	tk	<i>Team knowledge</i> development: team members clarify information to build team knowledge
4	FIELD	Marine 6, that's the other tower	itk	<i>Individual task knowledge</i> development: individual team member clarifying data, asking for clarification.
5	DISPATCH	That's the second tower at the World Trade Center	itk	<i>Individual task knowledge</i> development: individual team member clarifying data, asking for clarification.

When the Manhattan dispatcher needed a report of the state of the WTC after the South Tower collapsed, Ladder 43 offered their services from 57th Street and the West Side Highway to go to the scene and report back.

H. PROBLEMS WITH STANDARD OPERATING PROCEDURE

The purpose of the radio system is to ensure the rapid, accurate exchange of information between the dispatcher and the mobile units. All radio transmissions should begin by identifying the speaker and the addressee. According to the FDNY Communication Manual (1998), all radio communication must be brief and concise, avoiding repetitions and pleasantries. While radio transmissions should be courteous, courtesy can be overlooked in the interest of brevity. Any message requiring a reply from the addressee ends with "K," meaning "This is the end of my message to you and a response is necessary. Go ahead, transmit" (Communication Manual, 1998).

1. Minor Deviations, SOP Deviations Level 1

a. *Identifying Speaker and Addressee*

In many communication turns the speaker and addressee are identified in the radio transmission before the transmission with the information is passed, and this information is not repeated in the informative transmission. As seen in Table 18, Three and one is identified as the speaker addressing the Manhattan dispatcher in line 1, and the Manhattan dispatcher answers their request in line 2. In line 3, Three and one does not identify themselves again; instead just proceed with the message.

Table 18. Excerpt from FDNY Communications: Identifying Speaker and Addressee (Time: 8:54 am).

FDNY Communications			Cognitive Process Coding	
	Speaker		Code	
1	FIELD	Three and one to Manhattan, K.	misc	
2	DISPATCH	Three and one.	misc	
3	FIELD	Be advised we're responding. We'll be in the river for water supply.	tk	<i>Team knowledge</i> development: TMs clarify information to build team knowledge

While not re-identifying the speaker and recipient may be more efficient at the time and may take less time to transmit a message when the speaker already knows they have the addressee's attention, it may cause problems when a transmission is lost or blurred with another. There were instances where the speaker was asked to re-identify themselves, thus taking up more radio frequency time.

At other times, the speaker does not properly identify themselves or who they are addressing. For example, at 8:56 am, someone transmits on the radio, "Guys, it was a plane that struck the building." It could be assumed that the speaker wanted to address the radio audience as a whole, but that is not within the jurisdiction of a responding field unit. First and foremost, at no point is it acceptable to use the phrase "Guys" on a professional, emergency response frequency; while this speaks to the strong

sense of community shared by the firefighters, this was not appropriate for the radio. Furthermore, at 8:56 am, nine minutes after the plane flew into the North Tower, it was clear to the Manhattan dispatcher and most responding units that the explosion was a plane, making the transmission redundant. While further knowledge to help confirm assumptions in the team's mental model is a crucial part of team collaboration, excessive, redundant confirmations are not necessary and lead to radio transmission overload.

b. Requesting Ambulances and Units

The radio communication transcripts are filled with requests from responding units at the scene of the WTC for additional units, ambulances, and police support. A responding unit in direct contact with the Manhattan dispatcher is technically acting outside of the chain of command. The Manhattan dispatcher is not directly in the FDNY chain of command, instead is only connected through the Incident Commander, thus all requests should go through the Incident Commander. The Incident Commander orders whatever resources he needs to mitigate the situation at hand. The dispatcher then, in turn, reassigns companies according to the Incident Commander's requests (Communications Manual, 1998). When individual units are contacting the dispatcher it shows that the Incident Commander has lost control of the situation (Gannon, 2007).

It could be assumed that the firefighters relaying their requests to the Manhattan Dispatcher were trying to pass information to help the dispatcher gain perspective on the level of response needed, but they should have also adhered to their SOP and let the Incident Commander request what he needed at the scene of the fire (Gannon, 2007). Other than taking up the radio frequency, which is still a problem when there is so much communication going on, these transmissions did not heavily impact the radio environment.

c. Casual Communication

The communication manual advises that firefighters use a normal conversational tone on the radio, but the communication should be informative, not conversational. The firefighters did not adhere to SOP, and did use pleasantries on the radio. There are many instances in the radio transmissions where firefighters use

“please,” “thank you,” “do us a favor,” and even at one point “if you could do that I’d love you.” While these are minor deviations (SOP Deviation Level 1) and do not expend a lot of time on the radio frequency, it may also represent a tendency towards casual conversation on the radio, which could result in a more serious SOP deviation. Furthermore, casual conversation extended to using first names on the radio, which has the potential to get very confusing.

d. The 10 Codes

The 10 codes are Radio Signals to help abbreviate common radio transmissions (Communications Manual, 1998). The FDNY handles the 10 codes very well, using them appropriately, without having to ask the sender what they meant by the 10 code. A fire in a high-rise building is a 10-76, which was properly transmitted for the fire in the WTC. Furthermore, 10-4 after receiving and understanding messages was used properly, assuring those transmitting that the messages were sent successfully. There were cases where 10-4 was not transmitted to assure understanding, and the sender had to retransmit to ask if the message was received. One example of this is when Car 5 asked if the Manhattan dispatcher received their message about the new location of the command post. This is a major adjustment in the FDNY’s response, so it was critical to know that it was received and understood. In the case that this was not properly understood, it would have escalated the lack of a 10-4 to a SOP Deviation Level 3.

There are minor instances where instead of using the 10 code the firefighters say the phrase. For example, 10-5 means to repeat the message because it was not understood (Communications Manual, 1998), and while it was used three times throughout the radio transcripts there were many other instances where senders were asked to “repeat the message.” Another example is 10-6 which means to standby, and while “all units standby” was a common phrase on the radio, 10-6 was never used.

2. Major Deviations, SOP Deviation Level 2

Deviations where the results caused more than minor repercussions were coded as SOP Deviation Level 2. These deviations did not have a life threatening impact, but were still more serious than an SOP Deviation Level 1. For example, at 10:03 am, after the

South Tower collapsed, someone came on the radio to say, “George, have them mobilize the Army. We need the Army in Manhattan.” First, transmitting with the name “George” is an SOP violation, but asking for the Army is far beyond the authority of a responding firefighter at the scene. This transmission took up time on the radio and might have caused further implications for those other responding units who might now think that the Army is coming to help.

3. Major Deviations, SOP Deviations Level 3

a. Urgent Radio Messages²⁶

Deciphering one “urgent” message from another is difficult in the transcripts of September 11, 2001, because the Manhattan dispatcher continually requested, “All units standby unless urgent.” Therefore, it could be understood that all transmissions on the radio were inherently deemed “urgent” by the sender.

When an “urgent” was passed on the radio, all communication is supposed to stop to hear the urgent message. This was not the case, as seen in Table 19.

Table 19. Excerpt from FDNY Communications: Messages did not stop upon transmitting an “Urgent” (8:59 am).

	FDNY Communications	
	Speaker	
1	FIELD	Four David to Manhattan.
2	DISPATCH	Four David.
3	FIELD	How many rescues we got here?
4	FIELD	Marine 1 to Manhattan with an urgent message, K.
5	DISPATCH	At this time you have three rescues, K.
6	FIELD	O.K., I want all but one of them here.
7	DISPATCH	Ten-four.
8	FIELD	Marine 1 to Manhattan with an urgent message, K.
9	DISPATCH	Unit with an urgent message, K.
10	FIELD	This is Marine 1, we’re in the river. You’ve got fire out of the north side and now coming out of the west side of the World Trade Center, the west side.

²⁶ See Chapter V.D.1.a for a description of Urgent Messages.

Table 20 shows the types of message that should be classified as urgent with a corresponding example from the FDNY transcripts on September 11, 2001, where the message was not properly identified as urgent.

Table 20. Messages that should have been classified as Urgent with corresponding excerpts from FDNY communications that did not classify them as such.

Type of Urgent Message	FDNY Communications	
	Speaker	
Second or greater alarms	FIELD	Suggest to the incident commander, 4 David, to transmit a fifth alarm to Tower 2.
Calls for additional companies, ambulances, special units, or “10-75”	FIELD	Send every available ambulance, everything you’ve got, to the World Trade Center now.
Dispatchers’ orders to units away from quarters to respond to alarms	N/A	
Deployment of units or important messages to units at fire or emergency operations	DISPATCH	Engine 2-1-1, Ladder 1-1, Engine 4-4, Engine 2-2, Engine 5-3, Engine 4-0, yourself, Battalion 1-0, Battalion 1-2, Ladder 1-6, Ladder 2, Ladder 1-3, Engine 2-2-1, Engine 2-3, Engine 2-0-9, Engine 2-1-2, Engine 2-7-9, Engine 2-3-0, Engine 2-2-9, [interference], Engine 2-1-6, Engine 2-1-7, Engine [interference], Engine 2-1-4, Ladder 12, Ladder 1-1-8, Ladder 7, Ladder 2-4, High Rise 1 and Battalion 1-1. Division 3.
Report of apparatus breakdown while unit is responding to an alarm	FIELD	I’ve got... from the Port Authority telling me that the elevators are on the 44 th floor. Don’t use them, they’re about to come down.
Transmission of alarms, and broadcast of address of fire	FIELD	Transmit a third alarm throughout the staging area at Vescey and West Street. As the third alarm assignment goes into that area, the second alarm assignment report to the building, K.

Type of Urgent Message	FDNY Communications	
	Speaker	
Discovery of a structural problem indicating the danger of collapse	N/A	

While the firefighters did not transmit an urgent for those messages that warranted the “urgent” status, there were messages that were incorrectly transmitted as urgent. For example, when firefighters were reporting people trapped in the building on various floors, this is not classified as an urgent message by the SOP. While this is certainly a significant message, it is important to understand what kind of messages warrant the halting of all message traffic and the attention of high ranking officers.

There are other instances where messages that should have been a “mayday” were transmitted as “urgent.” When people were trapped under Tower 1 it was labeled an urgent, when this definitely qualifies as a life threatening injury, and thus, a mayday.

b. Mayday Radio Messages²⁷

At 10:24 am there was a report that the 22nd floor had collapsed in the North Tower. This was not transmitted as a mayday, and should have been given much more attention than it was. Due to the fact that the South Tower just collapsed, it was no longer assumed that the building could withstand the intense heat and pressure from the impact of the planes. In hindsight, this report happened four minutes before the North Tower collapsed. Other messages that should have been classified as maydays are labeled in Table 21.

²⁷ See Chapter V.D.1.b for a description of Mayday Messages.

Table 21. Messages that should have been classified as Mayday with corresponding excerpts from FDNY communications that did not classify them as such.

Type of Mayday Message	FDNY Communications	
	Speaker	
Imminent collapse feared	N/A	
Structural collapse has occurred	FIELD	Engine 3-9 acting, report on the 22nd floor, reporting a floor collapse at that location, K.
A firefighter is unconscious or suffers a life threatening injury	FIELD	We have a medical emergency, possible heart attack, firemen, we're on the bulkhead, west, requesting oxygen for the firemen, K.

At 10:47 am there was a report of member trapped in the promenade between the two towers. This was an SOP error in that the original transmission was not labeled a mayday, but this was corrected by the dispatcher, who relayed the message again as a “transmitted mayday.” A little before 11:00 am there began many messages about people trapped in the area surrounding the WTC. This severely deteriorated radio communication protocol as the trapped people began panicking. The use of mayday and urgent labels also escalated to the point where the trapped people began competing with each other for the radio frequency to ask for help.

c. Evacuation Orders

According to SOP, if a collapse is imminent firefighters are told to evacuate, and the person sending the message on the radio must repeat a “Mayday, Mayday, Mayday.” There were evacuation orders given on September 11, 2001, but many were not heard throughout the building due to the fact that the firefighters’ handi-talkie radios cannot transmit between many floors of concrete and steel. At 9:32 am, there was a report of a third plane heading towards New York City; the Command Chief in the lobby of the North Tower transmitted for everyone in the building to evacuate because the impact of a third plane would have made the situation unsafe for the responding firefighters. Still, after giving this order, no firefighters returned to the lobby

because soon after the order was given the chiefs in the lobby learned that the report of the third plane was false, and continued their rescue operations (Pfeifer, 2005).

According to accounts given to the McKinsey Corporation for the McKinsey report (2002, p. 33), “the First Battalion Chief, who was in charge of the Operations Post in WTC 1, immediately issued an evacuation order for WTC 1 over his portable (handie talkie) radio” after the South Tower collapsed. This evacuation order is recorded on film in *9/11*, and the First Battalion Chief did issue this order in adherence to FDNY SOP (Zirinsky et al, 2002).

The evacuation orders for the NYPD and the FDNY were very different. The NYPD helicopters in the area and those officers at the NYPD command post on Church and Vescey Streets were able to radio to the Emergency Service Unit (ESU) that the South Tower had completely collapsed and the North Tower looked as though it would soon follow. The ESU officers in the North Tower understood the level of urgency to evacuate the North Tower; this information was not relayed to the firefighters in the same danger in the North Tower (Pfeifer, 2005).

4. Instituting an FDNY-wide Recall

The FDNY has a protocol for department-wide recall, but the firefighters were not as familiar with it as they were with other SOP. The recall had not been activated for more than 30 years before September 11, 2001, and personnel were not trained in what to do in the case of its activation (McKinsey, 2002). The first time a recall is mentioned on the radio is at 9:06 am by Division 3 to Manhattan, seen in Table 22.

Table 22. Excerpt from FDNY Communications: The question of instituting a recall (Time: 9:06 am – 9:07 am).

	FDNY Communications	
	Speaker	
1	FIELD	All right, 10-4. Division 3 to Manhattan, call leader Car 4 David on the scene, do they want to institute a recall due to the incident, K?
2	DISPATCH	Manhattan calling Car 4 David. Manhattan calling Car 4 David, K. Manhattan calling Car 4 David.
3	FIELD	Division 3 to Manhattan.
4	DISPATCH	Division 3, go ahead.
5	FIELD	Did you give me the box that I'm being assigned to, K?
6	DISPATCH	Division 3, you're going to 2 World Trade Center. Box is 9998, K.
7	FIELD	Division 3, 10-4.

When Manhattan transmitted to Car 4 David after getting course of action from Division 3 it can be assumed that they were going to ask about the recall. However, Division 3 came back on the radio asking about their box assignment, followed by other responding units' questions, so the question was forgotten.

Finally, at 9:28 am, the Manhattan dispatcher went out with the recall message, "Attention all units, by the order of citywide tour commander, all off-duty firefighters and all off-duty officers are hereby recalled. Repeating, by the orders of the citywide tour commander, all off-duty firefighters and all off-duty officers, you are hereby ordered to recall immediately." This was immediately repeated, and repeated again at 9:37 am.

When the firefighters did begin to report there are reports of companies responding using the recalled firefighters, but there are no records on the transcripts of who reported where and when.

I. ADHERENCE TO SOP

1. Emotions

Indecent and profane language is prohibited on radio frequencies. In an emotionally charged situation such as September 11, 2001, it is very impressive that the

firefighters were able to keep their emotions in check. There were times when the Manhattan dispatcher had to remind the field units to “remain calm,” but overall, considering the level of stress, the firefighters maintained their composure.

2. Fallback Step 3

Fallback Step 3 is implemented when there is a situation in the city that is so large that the normal first alarm response to another fire is lowered. Once at the scene, the first alarm responder can evaluate the situation to see if more alarms are needed. On September 11, 2001, Fallback Step 3 was instituted at 9:01 am. The total number of fire calls was comparable to the same 24-hour period in 2000, 2,322 versus 2,225 respectively. While average fire response times did increase, regular fire operations were still maintained throughout the city. Response times returned to normal after September 15, 2001 (McKinsey, 2002).

3. Urgent Radio Messages

According to the communication manual, all other communication transmission is to cease when an “urgent” is transmitted on the radio, as seen in Table 23.

Table 23. Excerpt from FDNY Communications: Messages stop upon transmitting an “Urgent.”

	FDNY Communications	
	Speaker	
1	FIELD	Hazmat 1 to Manhattan.
2	DISPATCH	Hazmat 1.
3	FIELD	We are responding. We’re just out of the tunnel. Is there a specific route that is set up for emergency vehicles to get through, K?
4	FIELD	Marine 6 to Manhattan urgent.
5	DISPATCH	Hazmat 1, standby. Marine 6, go.
6	FIELD	You have a second plane into the other tower of the Trade Center, major fire.

In Table 23, the communication with Hazmat 1 stops to hear Marine 6’s urgent message. The urgent message is one of a “discovery of a structural problem indicating the danger of collapse” due to the impact of the plane.

Urgent messages were used correctly to report the planes hitting the towers, and subsequent collapse of both towers. Table 24 shows other messages that were transmitted as “urgent” and the corresponding urgent message that applies.

Table 24. Correct Use of “Urgent” Classification.

FDNY Communications Speaker		Type of Urgent Message
FIELD	Marine 1 to Manhattan with an urgent message, K.	Discovery of a structural problem indicating the danger of collapse Fire is entering an exposure to a degree that any delay may considerably enlarge the fire problem
DISPATCH	Unit with an urgent message, K.	
FIELD	This is Marine 1, we’re in the river. You’ve got fire out of the north side and now coming out of the west side of the World Trade Center, the west side.	
FIELD	Engine 317 to Manhattan, urgent.	Report of apparatus breakdown while unit is responding to an alarm
DISPATCH	Engine 3-1-7, go.	
FIELD	I’ve got... from the Port Authority telling me that the elevators are on the 44 th floor. Don’t use them, they’re about to come down.	
DISPATCH	Manhattan to Field Comm., urgent.	A firefighter suffers an injury that is not life threatening, but requires medical attention and hospital care
FIELD	Receive, Manhattan, Field Comm.	
DISPATCH	Tower No. 2, 19 th floor, firefighter down. Tower No. 2, 19 th floor, firefighter down.	
FIELD	Field Comm. Received.	
DISPATCH	Engine 33 urgent, go.	Loss of water which would endanger firefighters
FIELD	Engine 22 is being manned by an off-duty member from Rescue 1. Be advised it appears that we have lost water pressure down in lower Manhattan. Can you have Marine 1 or any other available fire boat respond to Vescey Street on the West Side? We’re going to need water supply into the area, K.	

4. Mayday Radio Messages

Even in the extremely stressful situation of September 11, 2001, only three “maydays” were called in the two hours and 31 minutes of radio transcripts. The first called mayday was at 9:04, when an engine company gave a report that a plane hit the South Tower. The engine transmitted, “This is mayday, mayday. Engine [inaudible] another plane hit the second tower, K.” Assuming this mayday falls under the mayday situation where an imminent collapse is feared (due to the impact of the plane), this mayday transmission is in agreement with the SOP.

After the South Tower fell, a civilian trapped in the rubble came on the Manhattan dispatch frequency asking for help. The communication between the civilian, the dispatcher, and the responding firefighter can be seen in Table 25.

Table 25. Excerpt from FDNY Communications: Civilian mayday call. (Time: 10:00 am).

	FDNY Communications	
	Speaker	
1	FIELD	I’m a civilian. I’m trapped inside one of your fire trucks underneath...
2	DISPATCH	Standby, there’s ... close to you
3	FIELD	I can’t breathe much longer. Save me! I’m in the cab...
4	DISPATCH	Transmitting a mayday. Where are you, K.
5	FIELD	I just told you. It’s north of the World Trade Center, there’s the north... bridge. I think it collapsed when the partial building just collapsed. I was on the street... Please, help me!
6	FIELD	... I copy that. I’m going to go look for her
7	DISPATCH	Ten-four.

While the civilian was not aware of the uses of “mayday,” the dispatcher came on the radio saying, “Transmitting a mayday” to get the attention of others on the radio to help the civilian. A firefighter who was responding to the scene was able to redirect their efforts towards this civilian.

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VII. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. Structural Model of Team Collaboration

a. *Use of the Codes*

Analysis of the communication turns of the firefighters in the FDNY on September 11, 2001, shows that they used 19 out of the 23 cognitive process codes. The four codes not used were *knowledge object development (ko)*, *individual visualization and representation of meaning (vrm)*, *iterative information collection and analysis (ica)*, and *solution adjustment against goal and exit criteria (sag)*. Even though these four codes did not pertain to the radio communication used by the FDNY, they may still pertain to other team collaboration environments and should therefore not be discounted from the collaboration model. For example, *individual visualization and representation of meaning* requires the usage of visual aids, and *knowledge object development* requires pictures and icons, all of which are impossible over the radio, but are still quite important for collocated teams.

b. *Chi Square Conclusions*

The Chi Square Analysis on the differences in the cognitive phases further prove the validity of the Structural Model of Team Collaboration. From a strictly subjective point of view, it is clear that the firefighters were dealing with very different levels of stress and response between when the first plane hit the North Tower and when the second plane hit the South Tower, and between when the South Tower collapsed and the North Tower collapsed. Due to the fact that a Chi Square analysis across all of the codes between cognitive phases one and two were significant to an alpha level of .001 speaks very highly of the model's ability to properly represent changes in a person's cognitive stress levels.

Furthermore, in the Chi Square analysis comparing the cognitive processes across two of the four cognitive phases, there were still very significant differences in

individual cognitive processes between phase one and two and phase one and four. Since the difference between cognitive phases one and two were found in the *individual mental model construction (imm)*, *individual task knowledge development (itk)*, and *team shared understanding development (tsu)* the model shows that the firefighters were working very hard to share knowledge and mental models with each other. The fact that the data are statistically different to the alpha level of .001 shows that the firefighters were working on a different cognitive level between the first cognitive phase, when they thought they only had one plane in one tower, to the second cognitive phase, when they were working with two planes in the two towers.

c. *The FDNY in the Model*

Coding the cognitive processes of the firefighters on September 11, 2001, provides a rich real world example for validating the Structural Model of Team Collaboration. Since the model was clearly able to apply to the firefighters' communication it shows that the model is able to apply to real world team applications. From the firefighters' real world communication turns the model has continued to grow, continually moving towards understanding a team member's cognitive processes during decisionmaking.

B. RECOMMENDATIONS

1. Structural Model of Team Collaboration

a. *Code Definitions*

Phrasing of some of the definitions of the cognitive process codes is a point of contention depending on how particular words are stressed with use of italics, bold, and underline. Primarily, it is difficult to understand the significance of the difference between the three types of emphasis used and which ones should be held absolute versus which can deviate from every single team member's participation. For example, in the description of *common understanding (cu)* all is underlined: "all team members combine individual pieces of knowledge to achieve a common understanding," but in the description of *team agreement on a common solutions (cs)* all is not underlined:

all team members agree on the *final plan*.” Instead, in team agreement on a common solution “final plan” is italicized and underlined without really clarifying the significance. In the higher cognitive levels where the team is drawing inferences and making the decision, the model requires that all team members participate in the discussion. With the goal of decreasing the subjectivity of coding the definitions should be more descriptive, with more examples. The suggestion is not to eliminate the emphasis in the definitions, but instead to provide a justification in either the cognitive process code descriptions or examples or both so that the coder understands the significance of the stress of that particular part of the cognitive process code.

b. Code Additions

A great deal of communication centered on team member’s actions they were taking at the time. A cognitive code of “*acting, (act)*” is proposed to cover these communications. This code would be defined as an individual team member taking an action to help the team towards the goal, or when an individual team member is unable to perform an action, or when another action taken is preventing them from helping the team towards the ultimate goal. In the radio transcripts from September 11, 2001, most of the communication turns that would have been coded *act* where coded as *tk*. Labeling an individual telling the team about an action they are taking towards the team’s ultimate goal is correctly labeled as *team knowledge development (tk)* without considering the new *acting* code. *Acting* is higher than *team knowledge development (tk)* because the team member is actively doing something to help the team towards the goal. An example of this in the FDNY communication transcripts is in Table 26.

Table 26. Excerpt from FDNY Communications: Coding for New Cognitive Code Acting.

FDNY Communications			Cognitive Process Coding	
	Speaker		Code	
1	DISPATCH	Transmitting a mayday. Where are you, K.	itk	<i>Individual task knowledge development: individual team member clarifying data, asking for clarification.</i>
2	FIELD	I just told you.	itk	<i>Individual task knowledge</i>

	FDNY Communications		Cognitive Process Coding	
	Speaker		Code	
		<p>It's north of the World Trade Center, there's the north... bridge.</p> <p>I think it collapsed on me when the partial building just collapsed. I was on the street... please help me!</p>	<p>tk</p> <p>imm</p> <p>rta</p>	<p>development: individual team member clarifying data, asking for clarification.</p> <p><i>Team knowledge development:</i> team members clarify information to build team knowledge</p> <p><i>Individual mental model construction:</i> individual team member develops a mental picture of problem situation</p> <p><i>Request take action:</i> team member requests another team member to take some action.</p>
3	FIELD	...I copy that. I'm going to go look for her.	act	<i>Acting:</i> team member is taking an action to help accomplish the team's goal
4	DISPATCH	Ten-four.	misc	Acknowledgement of message.

c. Future Uses of the Model

Insights from the model can serve as a guideline for teams going through the process of collaborating on information with the objective of arriving at a solution by increasing their awareness of successful collaboration communication techniques. A team using the model can also increase awareness of, and therefore reduce, cognitive overload. It could also help develop technology focused on working to amplify a person's cognitive activity, while helping to reduce overload (Hutchins, Bordetsky, Looney, & Bourakov, 2006). The model can also help highlight important areas for further research in ONR.

2. Team Decisionmaking

Before beginning to train a group of individuals to act as a team, it is necessary to understand the importance and relevance that, "To train teams to perform effectively as teams, they must be trained as teams" (Hackman, 1988). This seemingly simple statement has a great impact for those trainers who use it. Training individuals does not help the overall goal of training a team as well as training the entire team to act together.

Team decisionmaking literature offers few training suggestions for improved team performance. Problems found in team decisionmaking do not always stem from heuristics, biases, or other logical flaws that are easily identified and corrected with the appropriate training modules.

Klein's RPD Model²⁸ discusses the importance of properly assessing a situation before moving towards decisionmaking. Thus, a team could be trained in proper situational assessment to set the groundwork for efficient decisionmaking. Current team training is focused on preparing teams for certain situations and practicing responses and simulating the implications of their decisions as a team. While habit and automatic responses will help prepare teams for routine situations, it is crucial to train teams to think together to react to unusual cases.

3. The FDNY as a Team

a. Decisionmaking

While the FDNY may not have the funds, time, or resources to simulate different fires or situations, they can train their people as a team. Part of this training includes building a community of trust, which helps to develop the implicit communication that is characteristic of a high-performing team.

As previously discussed, problems faced by decision makers in the real world are often ill-structured. Due to the ever changing and unpredictable nature of the decisionmaking environment, it is important to create hypothetical situations in which to practice decisionmaking. Usually there is no "correct" decision for a situation, and once the decision is made and acted upon, there is no turning back. In an actual situation, the decisionmaker does not have the ability see if another decision would have generated a "better" solution. In a training environment there are capabilities to enable different scenarios to play out to see which decision would have generated the best results (Means, Salas, Crandall, & Jacobs, 1993).

²⁸ See Chapter III.B.4 for further discussion of Klein's RPD Model

Regardless of how much training the FDNY provides, at no point should decisionmaking become automatic (Means, Salas, Crandall, & Jacobs, 1993). It should always have a level of cognitive reasoning to check and validate solution options. There will always be slight variations in situations, and a firefighter should not try to fit every training module into the current decisionmaking scenario; piecing together a new solution is a sign of highly cognitive decisionmaking.

b. Team Training

According to Smith-Jentsch, Johnston, and Payne (2000) there are “four teamwork dimensions” that are important for performance that are also trainable. These dimensions are: information exchange, communication, supporting behavior, and team initiative/leadership (p. 84). The FDNY can work on their radio efficiency to improve their information exchange and communication. As seen from the radio transcripts, the firefighters are very good at supporting each other, seen in the high number of *course of action (coa)* and *request to take action (rta)* (seen in Tables 1 and 2), and have very strong leadership and personal initiative seen in low ranking firefighters.

The FDNY is a very strong community, including a network of retired officers. It would be beneficial for the FDNY to share this wealth of knowledge, to compare what the more experienced firefighter would have done in a situation with what the younger, firefighter in training would do. The two firefighters can compare their possible solutions, and create a discussion with other firefighters in training. To prepare for multiple levels of information at the scene of a fire, training should start at a very basic level of task complexity, and increase according to the trainee’s learning curve (Means, Salas, Crandall, & Jacobs, 1993).

It would be futile to recommend this training without taking into account the environment in which the training will take place. After September 11, 2001, people are more open to funding first responders, but there is still the competition for funding between agencies. Furthermore, there is the conundrum of spending money on training for an event on the scale of September 11, 2001, that will rarely occur in a person’s career (Timmons, 2006). But, it is still important to train and prepare for these situations

because practicing these techniques on a smaller scale will keep personnel ready for any larger incidents. Maintaining a collaborative environment during normal, everyday FDNY/NYPD responses would lead to enhanced collaboration during more intense, unknown attacks, such as September 11, 2001.

4. FDNY Communications

a. The 10 codes

The International Association of Chiefs of Police addressed the Department of Homeland Security proposing to eliminate the 10 codes. The Police Chiefs suggested that the 10 codes confuse communication when working with other departments. When the Department of Homeland Security Secretary Michael Chertoff introduced this proposal to local agencies it was turned down, in favor of keeping the communication SOP with the 10 codes.

This study of FDNY communication does not support this suggestion for removing the 10 codes, as the firefighters used the codes and seemed to understand their meaning, as the meanings were not questioned.²⁹ The 10 codes shorten radio transmissions, making radio frequency available for other communication.

b. Eliminating Common Questions

The radio transcripts contained many questions pertaining to traffic, and best routes to the scene, as well as locations of the staging area, and command post. This radio traffic could be eliminated or drastically reduced if this information was passed on the Mobile Data Terminal (MDT).³⁰ While only 46 questions out of 1626 communication turns were about traffic and staging area and command post locations, adding this information to the MDT report could save time for responding units.

²⁹ See Chapter VI.H.1.d for further discussion of the ten codes.

³⁰ For a description of the Mobile Data Terminal see Chapter V.B.1.a.

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VIII. FURTHER STUDIES

A. THE STRUCTURAL MODEL OF TEAM COLLABORATION

Further studies conducted to validate the Structural Model of Team Collaboration will contribute to the ultimate goal of understanding how individual cognitive processes impact team decisionmaking. These validation studies could come include experimental activities such as the MIO and simulated air warfare scenarios,³¹ or in the form of additional real world examples of teams collaborating on complex, information-rich decisionmaking problems.

1. Military Applications

In a military setting, teams are usually more goal oriented with a known task to accomplish. Using the Structural Model of Team Collaboration to analyze decisionmaking in military scenarios will show the effect of different cognitive stages on team decisionmaking, with the goal of helping the military team accomplish their goal more effectively.

2. The Impact of the Model on Teams

It would be interesting to see if providing training on the Structural Model of Team Collaboration impacts how an individual or a team collaborates. With intricate background knowledge of team cognitive processes, team members may begin to recognize the processes in themselves. This could come in the form of pushing and pulling more knowledge, maintaining situational awareness more often, and an increase in sharing individual mental models with the end goal of working them into a team mental model. This knowledge could also make fellow team members aware of cognitive stresses, recognizing a team member's need for information or support and relieving that cognitive stress.

³¹ For a further discussion of previous research done on the Structural Model of Team Collaboration see Chapter II.C.1.

B. RADIO COMMUNICATIONS

There is a great potential for further studies involving radios and radio communications. This is especially relevant considering the amount of money the DHS has set aside for communication improvements. An analysis of the impact and effectiveness of new radios, in addition to the impact of these radios on team communication is critical if the radios are to be deemed effective.

There is also potential for analyzing the effect of these radios on team communications and performance. Simply putting more radios in the hands of team members will not result in better communication. There needs to be team training using the new radios to prove that they are, in fact, having a positive impact on the team's collaboration. Training will ensure that team members are communicating on the radio instead of merely talking and occupying the radio frequency.

APPENDIX A: COGNITIVE CODES IN THE STRUCTURAL MODEL OF TEAM COLLABORATION

Table 27. Cognitive Process Definitions. (From Warner, Letsky, & Cowen, 2004; examples from Hutchins, et al, 2006).

Cognitive Process Definitions	
1.	<p>Metacognition dti: individual conversion of <u>data</u> to <u>information</u> = individual team member converting data to information.</p> <ul style="list-style-type: none"> • “We have Don-2 bearing 086 and LN-66 bearing 097.”(converted detected radar parameters –<i>data</i> to <i>information</i> – names of radars on specific bearings) • “I am showing 8044 at 400 knots and about 27 thousand feet, possible comm-air type profile.” • “I have a second contact at 1000 feet.”
2.	<p>Macro cognition imm: individual mental model construction = individual team member, using available information, develops his/her mental picture of problem situation.</p> <ul style="list-style-type: none"> • “8030 definitely originated from Iranian airspace? The possible helo?” • “That’s affirmative, sir.” • “APQ-120 bears 072 off possible Foxtrot 4 Delta or Echo.” • “We have 8053, that air unknown coming in up there.” • “2017 is squawking a comm-air mode 3. In company with 2025, but that track is much lower than the comm-air. One at 37000, one at 8000 just came in low.”
3.	<p>Macro cognition itk: individual task knowledge development = <u>individual</u> team member asking for clarification to data or information; response to clarification.</p> <ul style="list-style-type: none"> • “Do we have the track number for his CAP? I would prefer to have the track number for his CAP.” • “Are you covering with birds?” • “That’s affirmative, sir.” • “Did you illuminate him?” (clarifying action has been taken) • “Did you establish communications with him?” • “Since he is turning to the east do you still want us to continue with level one?” (clarification of actions to be taken) • “That’s a negative.” (response) • “The Desert Eagle don’t have that information for you right now. I asked them to get that for us. Whether the F-1s were clean or dirty.”
4.	<p>Macro cognition tk: team knowledge development = All <u>team members</u> participate in clarifying (i.e. answering a question) information to build team knowledge.</p> <ul style="list-style-type: none"> • “Rainbow is sending Desert Eagle 101 and Desert Eagle 102 over to investigate track 8037 (TN 7034).” • “He looks like he is on a [air] corridor, Kuwait City to Bushehr.” • “Received ESM of Cyrano 4 bears 121 off the F-1.” (I) --- information • “No response track 8070.” (I) --- information • “I don’t have mode 3 or any other type of IFF available to me right now.” • “They’re going too fast for that.”

	<ul style="list-style-type: none"> • “Looks like he’s comm-air, he’s high and looks like a comm-air profile.”
5.	<p>Macro cognition ko: knowledge object development = pictures, icons or standard text, developed by an individual team member or the whole team, that represents a standard meaning to the team.</p> <p>--- [No coded examples for air warfare]</p>
6.	<p>Macro cognition vrm: individual visualization and representation of meaning</p> <p>Visualization = individual team members use methods (e.g., graphs, pictures) to transfer meaning to other team members.</p> <p>Representation = individual team members use methods to sort data and information into meaningful chunks.</p> <p>--- [No coded examples for air warfare]</p>
7.	<p>Metacognition cu: team integration of individual knowledge for common understanding = <u>all</u> team members combine individual pieces of <u>knowledge</u> to achieve a common understanding.</p> <ul style="list-style-type: none"> • “Track 7005 has turned west and is now inbound, sir.” • “He’s holding in altitude, he’s not far from the air way, he flew out of good guys country and we have a comm-air radar. Let’s make him assumed friend.”
8.	<p>Macro cognition kio: knowledge interoperability development = team members exchanging knowledge among each other.</p> <ul style="list-style-type: none"> • “Desert Eagles report “tally ho” on section of two Iranian F-1s, out.” --- (derived knowledge from aircraft providing a visual identification) • “We have Primus 40, bears 135, Gulfstream 2, possible Super Puma.” • “It looks like the AWACs is feet dry. The CAP, composition 2, appear to be headed feet dry now.” • “Doctrine won’t work for 2017, make unknown assumed enemy.”
9.	<p>Macro cognition ica: iterative information collection and analysis = <i>collecting</i> and <i>analyzing</i> information to come up with a solution but <u>no specific solution mentioned</u>.</p> <ul style="list-style-type: none"> • “No response initial warning, track 8037.” • “We need a report from CAP as to whether those, upon intercept of those suspected Pumas, whether they are armed or not.” • “Track 2017 deviated from known flight path still maintaining altitude and still squawking the same mode 3.”
10.	<p>Macro cognition tsu: team shared understanding development = discussion among <u>all</u> team members on a particular topic or data item (i.e. discussion does not involve answering questions)</p> <ul style="list-style-type: none"> • “Track 8061 bearing 027 Princeton at 25 miles, 5000 feet, heading south, covering with birds.” • “It looks like he is turning to the west.” • “You need to watch him closely here.” • “Track 8061 appeared to originate from Iran. When we picked him up he was already off the coast but he was coming south from close to the Iranian coast. I can’t confirm that he came from Iran but he was coming from that direction.” • “I am showing a CPA of 43 miles to the south at their current heading.” • “Cyrano 4, that emitter has ceased. Last bearing for Cyrano 4 was 122.” • “OK, what do we think about the Saudi CAP? Shot down, too low to communicate?” • “It looks like we still have a good track on them, 27 at 13000. Probably just poor comms with the AWACS.”

	<ul style="list-style-type: none"> • “Continue to track sections of Iranian F-1s and F-4s. Approached the force with an attack profile. Interrogated level 1 with no response. They turned away from the force at a range of about 30 miles. Continuing to track.”
11.	<p>Macro cognition sa: develop, rationalize and visualize solution alternatives = using data to justify a solution</p> <ul style="list-style-type: none"> • “I would like fire control lock up on 7010 and I’d like to make sure he is designated as a gun target. I’d like to have two rounds of illumination prepped on mount 52.” • “My intentions are to issue a warning shot with a flare if the helo proceeds to within ten nautical miles, over.” • “Indicate to 7010 that if he continues to close he can expect defensive actions.” • “Track number 7010 continuing inbound, request permission to engage at three nautical miles, no response to all measures, so far.”
12.	<p>Macro cognition cmm: convergence of individual mental models to team mental model = convincing other team members to accept specific data, information or knowledge</p> <ul style="list-style-type: none"> • “OK, we need to make them assumed enemy and cover them , AAWC.”
13.	<p>Metacognition cs: team agreement on a common solution = all team members agree on the <u>final plan</u>.</p> <ul style="list-style-type: none"> • “Listen up. 8044 is a probable comm-air, 8100 is an assumed hostile.” • “8044 looks like a comm-air profile.” • “ID 2010 unknown assumed friend.” • “Request batteries release on track 7010, it is continuing inbound, he is at three nautical miles, request permission to engage, over.”
14.	<p>Macro cognition tn: team negotiation of solution alternatives = team negotiation of solution alternatives ending in a final solution <u>option</u>. (solution options are defined for each of the five components of the final plan --- i.e. personnel, transportation, weapons, critical times and detail plan)</p> <p>--- [No coded examples for air warfare]</p>
15.	<p>Macro cognition tpr: team pattern recognition = the team as a whole identifies a pattern of data, information or knowledge.</p> <p>--- [No coded examples for air warfare]</p>
16.	<p>Macro cognition ct: critical thinking = Team working together toward a common goal, whereby goal accomplishment requires an active exchange of ideas, self-regulatory judgment, and systematic consideration of evidence, counterevidence, and context, in an environment where judgments are made under uncertainty, and there is limited knowledge and time (Hess & Freeman, 2004).</p> <p>2. <u>critical thinking is measured as a composite of:</u> (Warner & Wroblewski, 2004; Hess & Freeman, 2004)</p> <ul style="list-style-type: none"> • MCitk: individual task knowledge development = individual team member clarifying data; asking for clarification. • MetCcu: team integration of individual knowledge for common understanding = one or more team members combine individual pieces of knowledge to achieve a common understanding. • MCKIO: Knowledge Interoperability = team members exchanging <u>knowledge</u> among each other. • MCsa: develop, rationalize and visualize solution alternatives = using

	<p>data to justify a solution</p> <p>Note: one critical thinking frequency count = oneMCitk +oneMetCcu + MCKio + MCsa</p>
17.	<p>Macro cognition shk: sharing hidden knowledge = individual team members sharing their knowledge through prompting by other team member(s).</p> <ul style="list-style-type: none"> • “We still have no level two warnings out to those guys.” • “Yes sir, we ID’d him as a com[mercial] earlier, we will go ahead and talk to him.” • “I’ve got track 7011 ID’d as com-air. He started out at 35,000 feet, now he is descending.”
18.	<p>Metacognition sag: solution adjustment against goal and exit criteria = team as a whole compares complete solution option against goal and exit criteria.</p> <ul style="list-style-type: none"> • “Ceased illumination 8005, maintaining lock on 8005. Turning outbound.”
19.	<p>Macro cognition csg: compare solution options against goal(s) = team members discuss solution options (i.e. any of the five solution components) against the scenario goal (i.e. rescue 3 red cross workers within 24 hrs).</p> <ul style="list-style-type: none"> • “Ah Rainbow’s holding track number 7011, low and slow and inbound. Do you desire me to cover with birds also?”
20.	<p>Macro cognition aro: analyze, revise solution options = team members analyze final solution options (i.e. any of the five solution components) and revise if necessary.</p> <p>--- [No coded examples for air warfare]</p>
21.	<p>Miscellaneous: misc = acknowledging a message, asking for repeat of message, verbal warning</p> <ul style="list-style-type: none"> • “Copy all, out.” • “What was your last?” • Verbal warning issued to inboard aircraft
22.	<p>Issue order regarding a course of action: coa = a superior in the chain of command tells a team member to take a specific action against a possible threat track.</p> <ul style="list-style-type: none"> • “Cover 8032 (TN 7013) with standard missile also generate a SWG 1A solution on him.” • “Cease illumination.” • “Let’s start level ones, 8070.”
23.	<p>Request take action: rta = team member requests another team member take some action.</p> <ul style="list-style-type: none"> • “Let’s investigate with CAP.” • “Confirm that tracks originating from Iranian air space are designated unknown assumed hostile.” • “Have SWC develop a Harpoon solution on him.” • “Go ahead and tag 8037 as F-1s.” • “Make 8037 and company assumed hostile.” • “Shift your focus Air to 8070, inbound helo.” • “Increase speed as well.”

APPENDIX B: MANHATTAN DISPATCHER TRANSCRIPTS FROM SEPTEMBER 11, 2001 8:46 AM THROUGH 11:07 AM

TIME	MESSAGE	FINAL CODE
	FIELD (F). Battalion 1 to Manhattan.	misc
8:47	DISPATCH (D). Battalion 1.	misc
	F. We just had a plane crash into upper floors of the World Trade Center.	tk
	Transmit a second alarm and start relocating companies into the area.	coa
	D. Ten-four, Battalion 1.	misc
	F. Battalion 1 is also sending the whole assignment on this box to that area, K.	tk
	F. Engine 6 to ...	misc
	D. Engine 6.	misc
	F. The World Trade Center tower No. 1 is on fire, the whole outside of the building. There was just a huge explosion.	tk
	D. Ten-four. All companies standby at this time.	rta
	F. [inaudible]	misc
	D. Ten-four.	misc
	F. Engine 1-0 to Manhattan.	misc
	D. Engine 1-0.	misc
	F. Engine 1-0, World Trade Center 10-60. Send every available ambulance, everything you've got, to the World Trade Center now.	coa
	D. Ten-four, 10-60 has been transmitted for the World Trade Center, 10-60 for the World Trade Center.	cu
	F. Three Truck to Manhattan.	misc
	D. Three Truck.	misc
8:48	F. Civilian reports from up here a plane just crashed into the World Trade Center for your information.	tk
	D. Ten-four, K.	misc
	F. ... available.	misc
	F. Battalion 1 to Manhattan.	misc
	D. Battalion 1, K.	misc
	F. We have a number of floors on fire.	tk
	It looked like the plane was aiming towards the building.	tk
	Transmit a third alarm throughout the staging area at Vescey and West Street. As the third alarm assignment goes into that area, the second alarm assignment report to the building, K.	imm
	D. Ten-four. Second alarm assignment report to the World Trade Center, second alarm assignment report to 1 World Trade Center.	cmm
	F. Engine 1-0 to Manhattan.	misc
	D. Engine 1-0, K.	misc
	F. It appears an airplane crashed into the World Trade Center.	tk
	D. Ten-four. Third alarm's been transmitted box 8087, third alarm transmitted box 8087 for 1 World Trade Center.	tk
	F. Squad 1-8 to Manhattan, K.	misc
8:49	D. Squad 1-8, K.	misc

	F. ... looked like it was intentional. Inform all units coming in from the back it could be a terror attack.	imm
	D. Ten-four. All units be advised -	cu
	F. ... to Manhattan.	misc
	D. ... , K.	misc
	F. ... to Manhattan, just so you know, this is confirmed, this is confirmed.	cu
	D. This is confirmed. Ten-four, K.	misc
	F. Engine 1-0 to Manhattan.	misc
	D. Engine 1-0, go.	misc
	F. Roll every available ambulance you've got to this position.	coa
	D. Ten-four, K.	misc
	F. Rescue 2 to Manhattan.	misc
	D. Rescue 2, go.	misc
	F. Are we assigned to any of your boxes in lower Manhattan, K?	itk
8:50	D. Rescue 2, standby.	itk
	F. Division 1 to Manhattan, K.	misc
	D. Division 1, K.	misc
	F. ... responding, have another rescue squad out.	coa
	D. Ten-four. Rescue 2, start out to box 8087, K.	coa
	F. Rescue 2's responding, K.	tk
	F. Squad 1-8 to Manhattan, K.	misc
	F. Rescue 1 to Manhattan, what do you have in on this?	itk
	...	misc
	F. ... 1 to Manhattan.	misc
	D. Division 1, go with your message.	misc
	F. What's the response ... right now?	itk
	D. Division 1, you now have a third alarm assignment to the box, K.	tsu
	F. Division 1, 10-4, that's confirmed. We have fire on several floors, the upper floors of the World Trade Center.	diti
	D. Ten-four, Division 1.	misc
	? K, I've got another siren.	misc
8:51	...	misc
	F. Four-zero Bravo to Manhattan.	misc
	D. Four-zero Bravo ...	misc
	F. Four-zero Bravo's responding to the World Trade Center.	tk
	D. Ten-four, K.	misc
	F. Forty Adam[?] to Manhattan.	misc
	D. Forty Adam.	misc
	F. On the way to the Trade Center.	tk
	D. Ten-four.	misc
	D. Third alarm has been transmitted box 8087, No. 1 World Trade Center.	tsu
	F. Fire 5 to Manhattan. Engine Fire 5 to Manhattan.	misc
	D. Engine Fire 5.	misc
	F. Please have ambulances respond to West Street, we have several injured people on West Street here.	rta
	D. Ten-four, Engine 5.	tk
	D. Ten-four, Engine 5.	misc
8:52	F. Battalion 1 to Manhattan, K.	misc

	F. Two-one-four to Manhattan.	misc
	F. This is Battalion 1 to Manhattan, K.	misc
	F. Three truck to Manhattan.	misc
	D. Three truck, go.	misc
	F. We're at Houston and West Broadway.	tk
	We can see this from here. We've been directed by numerous civilians.	imm
	You want us to take this in or you want us to stand fast?	itk
	D. Take that in, K.	coa
	F. [inaudible]	misc
	F. Brooklyn to Manhattan.	misc
	D. Brooklyn, go.	misc
	F. On the ... information Brooklyn is transmitting a box at the Brooklyn end of the Battery Tunnel.	tk
	We will use this as a staging area for apparatus to respond to Manhattan.	ct
	D. Ten-four.	misc
8:53	F. Division 1 to Manhattan.	misc
	D. ...	misc
	F. The staging area at the fire scene here is beyond West Street.	kio
	All units respond into West Street. Transmit a 10-60 also.	coa
	D. All right, 10-60's been transmitted, box 8087, 10-60, box 8087 for 1 World Trade Center.	tk
	All units responding into box 8087, the staging area will be at West Street, K.	tsu
	F. [inaudible]	misc
	F. ... Manhattan.	misc
	F. Four David to Manhattan.	misc
	D. Car 4 David, go with your message.	misc
	F. Do we have any report on a fire condition yet from on-scene personnel?	itk
	D. Division 1 reports numerous floors on fire, K.	itk
	F. Is this the second alarm right now?	itk
	D. This is a third alarm, a 10-60 has been transmitted, K.	itk
	F. Four David, 10-4.	itk
	F. Rescue 3 to Manhattan on your frequency.	tk
8:54	F. Three and one to Manhattan, K.	misc
	D. Three and one.	misc
	F. Be advised we're responding. We'll be in the river for water supply.	tk
	Advise incoming that you have visible flames from the side of the building.	imm
	D. Ten-four. Incoming units, be advised visible flames from the side of the building.	cmm
	F. Forty Adam to Manhattan.	misc
	D. Manhattan calling Division 1.	misc
	D. Manhattan calling Division 1, K. Manhattan calling Division 1, K.	misc
8:55	F. Rescue Four to Manhattan, K.	misc
	D. Rescue Four.	misc
	F. ... responding, K.	misc
	D. Ten-four.	misc
	F. Battalion 7 to Manhattan, K.	misc
	F. One-one-zero to Manhattan.	misc
	D. Battalion 7 go with your message. Battalion 7 go with your message.	misc

	F. Whatever it was hit the north side of the building.	tk
	Fire is venting from at least one floor, heavy smoke's all over the front and top of the building, approximately 90-something floor, K.	imm
	D. Ten-four.	misc
	D. Manhattan calling Division 1, K.	misc
	F. Division 1 to Manhattan, go ahead.	misc
	D. Division 1, receiving reports floor No. 106, numerous people trapped, floor No. 106.	tk
	F. Ten-four. We have units on the way up now. Reported fire on the 78th floor. That's unconfirmed at the time.	tk
	We're going to need the P.D. for security on the entire World Trade Center.	rta
	We have ... coming from the World Trade Center ... [inaudible]	tk
8:56	D. Ten-four.	misc
	F. Ladder 1-1-0 to Manhattan. We're on your frequency now.	tk
	D. Ten-four.	misc
	F. Battalion 7 to Manhattan.	misc
	?. Guys, it was a plane that struck the building.	tk
	D. Battalion 7 go with your message, K.	misc
	F. I'm going to turn on ... battalion car as a back up for the building repeater, K.	tk
	D. Battalion 7, 10-5 that message.	misc
	F. Squad 2-8-8 to Manhattan, K.	misc
	D. Squad 2-8-8.	misc
	F. On your frequency responding. Can you send up a ticket please?	rta
	D. Ten-four.	misc
	F. Car 3 to Manhattan, K.	misc
8:57	D. Car 3, go.	misc
	F. Car 3 and Car 4 are arriving together responding down.	tk
	Transmit a fifth alarm for this box. Get us a staging area ... somewhere on West Street, K.	coa
	D. Ten-four.	misc
	D. A fifth alarm has been transmitted, box 8087. A fifth alarm has been transmitted, box 8087, for No. 1 World Trade Center.	tk
	F. [inaudible]	misc
	D. Go with your message, K.	misc
	F. [inaudible]	misc
	D. Unit calling, go with your message -	misc
	F. [inaudible]	misc
	F. Battalion 2 to Manhattan.	misc
	D. Battalion 2, go.	misc
8:58	F. Be advised we have jumpers, K, jumpers.	tk
	D. All right, Division 1, be advised, Battalion 2 advised we have jumpers from the World Trade Center, K.	tk
	F. Division 1 to Manhattan.	misc
	F. Three and one to Manhattan, K.	misc
	D. Division 1, go with your message.	misc
	F. Those jumpers, did they already jump?	itk
	D. Battalion 2, have those jumpers jumped, K?	itk
	F. [inaudible]	itk

	D. Battalion 2, do you have jumpers down?	itk
	F. [inaudible] Manhattan.	itk
	D. Division 1, Battalion 2 is advising jumpers down, K.	itk
	F. Forty Charlie to Manhattan.	misc
	D. Forty Charlie, go.	misc
8:59	F. Forty Charlie is responding. Be advised you've got all boats available for any transport through the river ... rescue ...	tk
	D. Ten-four, K.	misc
	F. Four David to Manhattan.	misc
	D. Four David.	misc
	F. How many rescues we got here?	itk
	F. Marine 1 to Manhattan with an urgent message, K.	misc
	D. At this time you have three rescues, K.	itk
	F. O.K.,	itk
	I want all but one of them here.	coa
	D. Ten-four.	misc
	F. Marine 1 to Manhattan with an urgent message, K.	misc
	D. Unit with an urgent message, K.	misc
	F. This is Marine 1, we're in the river.	tk
	You've got fire out of the north side and now coming out of the west side of the World Trade Center, the west side.	cmm
	D. All right, fire from the north side and the west side of the World Trade Center.	cmm
	F. That's affirmative. Fire has penetrated the skin.	cmm
	F. Marine 6 to Manhattan.	misc
9:00	D. All right, box 8087, report of smoke 83rd floor, 103 floor, 104 floor. Also received reports of people trapped on floor No. 106, K.	tk
	F. Marine 6 to Manhattan.	misc
	D. Marine 6.	misc
	F. We're getting your frequency underway.	tk
	You also have fire out of the east side of the building.	cmm
	D. Ten-four, Marine 6.	misc
9:01	F. Car 4 David to Manhattan.	misc
	D. Car 4 David.	misc
	F. Ten eighty-four at the World Trade Center.	tk
	D. Car 4 David, repeat that?	itk
	F. Ten eighty-four.	itk
	D. Car 4 David, we're getting reports from the 104th floor, back room, 25 to 30 people trapped. I also have the 103rd floor, northwest room, 103, with people trapped also. I have the 83rd floor with people trapped as well. Car Four David, received?	tsu
	F. Car 4 David, 10-4.	misc
	D. All right, 10-4. Time is 09:01.12.61.	misc
	F. Car 9 Sally to Manhattan.	misc
	D. Car 9 Sally.	misc
	F. Go to fallback step 3.	coa
	F. Car 4 to Division 1.	misc
	D. Fall back step 3 has been implemented. Fall back step 3 has been implemented, K.	coa

	F. Car 40 Adam to Manhattan.	misc
	D. Car 4-0 Adam, go.	misc
	F. Would you relocate the only rescue that's not going to the Trade Center, put them in Rescue 1 in Manhattan, please.	rta
	D. Ten-four.	misc
9:02	F. Squad 4-1 to ...	misc
	D. Squad 4-1, K. Manhattan calling Squad 4-1.	misc
	F. Squad 4-1 to Manhattan.	misc
	D. Squad 4-1, relocate to Squad 1-8, K.	coa
	F. Squad 4-1, 10-4.	misc
	F. Four-zero Bravo to Manhattan.	misc
	D. Four-zero Bravo, K.	misc
	F. Can you confirm that Hazmat 1 is responding to the 10-60?	itk
	D. They've been assigned, K.	itk
	F. Hazmat 1 to Manhattan.	misc
	D. Hazmat 1.	misc
	F. We are responding. We're just out of the tunnel.	tk
	Is there a specific route that is set up for emergency vehicles to get through, K?	itk
	F. Marine 6 to Manhattan urgent.	misc
	D. Hazmat 1 standby. Marine 6, go.	misc
9:03	F. You have a second plane into the other tower of the Trade Center, major fire.	tk
	D. Car 4 David, Marine 6 advising a second plane into the World Trade Center, K.	tk
	F. Marine 6, that's the other tower.	itk
	D. That's the second tower at the World Trade Center, K.	itk
	F. Brooklyn to Manhattan.	misc
	D. All units standby unless urgent. Manhattan calling Car 4 David, K. Manhattan calling Car 4 David.	rta
	F. Car 4 David to Manhattan.	misc
	D. Be advised, report of a second plane that crashed into the second tower.	imm
	Be advised on the 83rd floor, room 8311, we have people trapped, room 8311, 83rd floor. Car 4 David acknowledge.	tk
	F. Car 4 David, 10-4.	misc
9:04	F. Marine 6 to Manhattan.	misc
	D. Marine 6, go with your message.	misc
	F. Marine 6, that plane was a large bomber-style green aircraft into the second tower, be advised.	dti
	D. All right, 10-4.	misc
	F. This is mayday, mayday. Engine - another plane hit the second tower, K.	tk
	D. All right, 10-4.	misc
	D. Manhattan calling Car 4 David.	misc
	F. Three Adam to Manhattan.	misc
	D. Three Adam, go ahead.	misc
	F. I'm on the F.D.R. Drive. Definitely something hit the second tower, possibly two-thirds of the way up. You've got visible fire showing out there.	cmm
	Suggest to the incident commander, 4 David, to transmit a fifth alarm to Tower 2.	sa
	D. Manhattan calling Car 4 David.	misc
	F. Brooklyn to Manhattan with an urgent.	misc

	D. Standby unless urgent.	rta
9:05	D. Manhattan calling Car 4 David, K. Manhattan calling Car 4 David. Manhattan calling Division 1, K.	misc
	F. Division 1, K.	misc
	D. Division 1, be advised, 3 Adam reports that you have a second plane that crashed into the second tower about two-thirds of the way up.	cmm
	He would recommend you transmit a fifth alarm for that tower as well.	cs
	F. Yeah, 10-4 ... Manhattan. Proceed with your ...	misc
	D. All right, 10-4.	misc
	F. Tactical Support 2 to Manhattan.	misc
	D. Tactical Support 2, go ahead.	misc
	F. Send me a ticket,	coa
	entering the tunnel.	tk
	D. All right, 10-4.	misc
	F. ... Car to Manhattan.	misc
	D. Go ahead ...	misc
	F. We're 10-84 this box.	tk
	Do us a favor, please. Will you call our bosses downtown and have them secure the [M.C.C.?)	rta
	We're located at Broadway and Maiden Lane, at Broadway and Maiden Lane.	tk
	Have them ... the [M.C.C.?) to this location.	coa
	We do need help here.	tpr
9:06	D. All right, what is that location?	itk
	F. On Broadway and Maiden Lane.	itk
	Best to have the [M.C.C.?) and have our personnel be secure here at this location.	sa
	D. The [M.C.C.?)	itk
	F. I'm requesting that at this location,	itk
	we've got to buildings on fire here.	sa
	F. Unit 4 to Manhattan, K.	misc
	D. Unit 4 to Manhattan, go ahead.	misc
	F. Engine 1-4.	misc
	D. One-four, go ahead.	misc
	F. We're at Houston and Broadway, available for the World Trade Center.	tk
	D. All right. Engine 1-4 remain in service at this time. Standby.	coa
	F. Division 3 to Manhattan.	misc
	D. Go ahead, go with your message.	misc
	F. Division 3 to Manhattan.	misc
	D. Division 3, go with your message.	misc
	F. Are we being assigned to any of these boxes down at the World Trade Center?	itk
	D. Affirmative Division 3.	itk
	Continue in.	coa
	F. All right, 10-4. Division 3 to Manhattan, call leader Car 4 David on the scene,	coa
	do they want to institute a recall due to the incident, K?	itk
9:07	D. Manhattan calling Car 4 David. Manhattan calling Car 4 David, K. Manhattan calling Car 4 David.	misc
	F. Division 3 to Manhattan.	misc
	D. Division 3, go ahead.	misc
	F. Did you give me the box that I'm being assigned to, K?	itk

	D. Division 3, you're going to 2 World Trade Center. Box is 9998, K.	itk
	F. Division 3, 10-4.	itk
	F. ... to Manhattan.	misc
	D. Units calling Manhattan, one at a time, K.	coa
	F. Division 1 to Manhattan.	misc
	D. One Engine, go.	misc
	F. Division 1 to Manhattan. All incoming units into World 1 and World 2 Trade Center are to bring additional cylinders.	coa
9:08	D. Engine 1, repeat that, K. You were totally unreadable.	itk
	F. Division 1 to Manhattan. All responding units responding into No. 1 and No. 2 World Trade Center are to bring additional ... cylinders with them.	itk
	D. All right, all units standby unless urgent in the borough of Manhattan.	rta
	All units responding into No. 1 World Trade Center and No. 2 World Trade Center, bring all additional S.D.B.A.[?] bottles to the front of the building. All units to box 8087 and 998, No. 1 and No. 2 World Trade Center, bring your extra S.C.B.A. bottles to the front of the building, as per the division.	coa
	D. Other units calling Manhattan.	misc
	F. ... , K.	misc
	D. No problem, go ahead.	misc
	F. Have Field Comm. reports, that they bring vehicles in front of the American Express building on West Street, ... orders with Chief [Ingle?]	coa
	D. Manhattan calling Field Comm.	misc
9:09	F. We got it Manhattan. Thank you.	tk
	D. O.K., 10-4, Field Comm. Thank you.	misc
	F. Four Truck to Manhattan, K.	misc
	D. Four Truck, go ahead.	misc
	F. One-three-one to Manhattan.	misc
	D. One-three-one, standby.	misc
	D. Four Truck, go ahead.	misc
	F. ... tower would you like us to be starting into, Tower 1 or Tower 2, K?	itk
	D. Four Truck, go to 2 World Trade Center, K.	itk
	F. Four Truck, 10-4.	itk
	D. One-three-one, go ahead. Ladder 1-3-1. Other units calling Manhattan.	misc
	F. Ladder 11 to Manhattan.	misc
	D. Ladder 11, go ahead.	misc
	F. Which tower are we to respond into?	itk
9:10	D. You're going to 2 World Trade Center, K, two.	itk
	F. All right, we're going to two, 10-4.	itk
	D. And bring all your extra S.D.B.A.'s up with you, K.	coa
	F. Ten-four.	misc
	F. Squad Company 2 -	misc
	F. Engine 2 -	misc
	D. One unit at a time.	coa
	Two-one-one? The last squad company calling?	itk
	F. Squad 2-5-2 to Manhattan, K, we have our second [piece?] responding to the World Trade Center.	tk
	D. All right, 10-4, Squad 2-5-2. When you get there bring up all your extra S.C.B.A. bottles, K.	coa

	F. Ten-four	misc
	F. Division 3.	misc
	D. Division 3, go.	misc
	F. I can't pick up the five units that you assigned to my system on. Have you got it in the computer yet, K?	itk
	D. They should be on there now. Do you want a rundown?	itk
	F. No, let me try one more time in the computer because all I'm getting is like five units. I'll get back to you in a second.	itk
	D. All right. We're getting them on there as fast as check that.	itk
	F. ... 1-0 to Manhattan.	misc
9:11	D. One-zero, go ahead, K.	misc
	F. ... 1-0, inform everyone assigned to the scene responding on West Street or Liberty Street not to pull up in front of the building. We have ambulances and everybody else pulling up and we've got debris falling from the building. They have to stop short of the building either north or south.	cmm
	D. Ten-four.	misc
	D. Units responding in to the World Trade Center, do not pull in front of the building on West or Liberty, K. Units responding in to the World Trade Center, do not pull in front of the building in West and Liberty.	cmm
	F. Division 3 to Manhattan.	misc
	D. Division 3, go ahead.	misc
	F. For some reason it's only giving me a few units. You're going to have to give it to me over the radio. I'm ready to write.	itk
9:12	D. All right: Engine 2-1-1, Ladder 1-1, Engine 4-4, Engine 2-2, Engine 5-3, Engine 4-0, yourself, Battalion 1-0, Battalion 1-2, Ladder 1-6, Ladder 2, Ladder 1-3, Engine 2-2-1, Engine 2-3, Engine 2-0-9, Engine 2-1-2, Engine 2-7-9, Engine 2-3-0, Engine 2-2-9, [interference], Engine 2-1-6, Engine 2-1-7, Engine [interference], Engine 2-1-4, Ladder 12, Ladder 1-1-8, Ladder 7, Ladder 2-4, High Rise 1 and Battalion 1-1. Division 3.	itk
	F. Division 3, 10-4. That's all the units I've got, K?	itk
	D. That's all you've got at this time, K.	itk
	F. All right, 10-4. Thank you.	itk
	D. Ten-four.	itk
9:13	D. Four Bravo, you're calling Manhattan, K? Unit calling Manhattan, K.	itk
	F. Car 9 to Manhattan, K.	misc
	D. Car 9, go ahead.	misc
	F. Would you advise the mobile command vehicle to come in on West and Liberty Street, West and Liberty Street, K.	coa
	D. I already advised them.	misc
	F. What's their E.T.A.?	itk
	D. Manhattan calling Field Comm.	misc
	F. Manhattan, that's not the Field Comm. I want the mobile -	coa
	F. Division 3 to Manhattan.	misc
	D. Car 9, go ahead.	misc
	F. Manhattan, I want the Mobile Command Vehicle, not the Field Comm. The Mobile Command Vehicle is responding also, I want them at West and Liberty.	coa
	D. All right, 10-4. I'll advise.	misc
	F. Division 3 to Manhattan.	misc

	D. Division 3, go ahead.	misc
9:14	F. Notify units to get over to the West Side. Eleven Avenue is closed off, they've got a direct route to the World Trade Center. Everything below 24th Street, it's wide open to get down there if they're responding to these locations.	cmm
	D. You want them over on the West Side?	itk
	F. If they can get over to the West Side, 11th Avenue, it's wide open from 30th Street all the way south to the World Trade Center, K. The P.D.'s already got it shut down.	itk
	D. All right, 10-4. Units responding, if you can get over to the West Side, 11th Avenue's closed down [interference] 11th Avenue, West Side.	cmm
	D. Calling Mobile Command Vehicle, K. Manhattan calling Mobile Command Vehicle, K. Car 9, I'm unable to read them.	tk
	F. 10-4, Manhattan. Keep trying.	coa
	F. Car 3 to Manhattan.	misc
	D. Car 3, go ahead.	misc
	F. Get a hold of Field Comm. We need them on West and Vesey Street, K, Field Comm. on West and Vesey.	coa
	D. Ten-four. Field Comm. on West and Vesey, I got that.	misc
9:15	F. All right, 10-4.	misc
	D. Manhattan calling Mobile Command Vehicle, K. Manhattan calling Mobile Command Vehicle, K. Manhattan calling Car 3. Manhattan calling Car 3, K.	misc
	F. Car 3, go ahead, Manhattan.	misc
9:16	D. Car 3 are you 84 the box?	itk
	F. We are 10-84 the box. We are at West and Vesey, K.	itk
	D. All right. Listen I have some floors for you to check out.	coa
	F. ... Go ahead, Manhattan.	misc
	D. Mayor's Service, standby.	coa
	Car 3, in building two, the No. 8-2 floor, the No. 8-8 floor and No. 8-9 floor. On the 82nd floor it's the west. I have other floors.	tk
	Are you ready to copy?	itk
	F. Ten-four.	misc
	D. O.K., the 83rd floor in building one; the 104th floor; the 103rd floor, northwest corner, room 103; 106th floor; 83rd floor is 8-3-1-1 room; and the 82nd floor, east side, in building one.	tk
9:17	F. O.K. Manhattan, standby for a few minutes.	rta
	We're going to get Field Comm. set up, we'll be able to copy everything, K?	itk
	D. All right, 10-4. Just advise me when you're ready.	itk
	F. Ladder 1-7 to Manhattan.	misc
	D. Seventeen Truck, go ahead.	misc
	F. ... to Ladder 1-5.	misc
	D. All right, 10-4, 17.	misc
	F. Marine 6 to Manhattan.	misc
	D. Marine 6, go ahead, K.	misc
	F. We're the marine division, we will position by the Brooklyn Bridge for a possible transport of men and equipment to Manhattan.	tk
	D. All right, 10-4.	misc
	F. Car 9 to Manhattan.	misc
	D. Car 9, K.	misc

	F. Would you have units responding on the fifth alarm for 2 World Trade Center, that's No. 2 World Trade Center, report to Chief Barbera [sp?] at West and Liberty Street, West and Liberty Street, K?	coa
	D. ...	misc
	F. Engine 1-4 to Manhattan, K.	misc
	CAR 9. That's correct. That's the command post for No. 2 World Trade Center, West and Liberty Street.	tk
9:18	D. Ten-four, Car 9.	misc
	F. Engine 1-4 to Manhattan, K.	misc
	D. All units standby unless urgent, O.K.?	rta
	F. Four Bravo to Manhattan, K	misc
	D. Four Bravo, go ahead.	misc
	F. Have Field Comm. report in front of the Financial District Building on West Street ... American Express immediately.	coa
	D. Ten-four. They're on their way. All units standby.	misc
	D. Units responding in to 2 World Trade Center, respond to West Street and Liberty and see Chief Barbera. Units responding to 2 World Trade Center, respond to West and Liberty and see Chief Barbera at that location,	coa
	he's the incident commander at that location.	tk
	F. Engine 1-4 to Manhattan, K.	misc
	D. One-four, go ahead.	misc
	F. From the Water Street box we're stuck in massive traffic, we can't get up to 31st and Madison.	tk
	D. All right, 10-4, Engine 1-4.	misc
9:19	F. ... to the World Trade Center. We're down there.	tk
	F. Car 9 to Manhattan.	misc
	D. Car 9, go ahead, K.	misc
	F. Give me the company identifications that are coming to 2 World Trade Center. Just read them down.	itk
	D. All right, 10-4: Engine 2-1-1, Ladder [interference], Engine 2-2, Engine 5-3, Engine 4-0, Division 3, Battalion 1-0, Battalion 1-2, Ladder 1-6, Ladder 2, Ladder 1-3, Engine 2-2-1, Engine 2-3, Engine 2-0-9, Engine 2-1-2, Engine 2-7-9, Engine 2-3-0, Engine 2-2-9, Engine 2-3-5, Engine 2-2-0, Engine 2-1-6, Engine 2-1-7, Engine 2-3-8, Engine 2-1-4, Ladder 12, Ladder 1-1-8, Ladder 7, Ladder 2-4, High Rise 1 and Battalion 1-1, Engine 7-4, Engine 7-6, Engine 4-7, Engine 5-8, Engine 9-1, Ladder 2-2, Ladder 2-5, Ladder 3-5, Four Truck and Ladder 2-1.	itk
9:20	F. O.K. Thank you, Manhattan.	misc
	D. Ten-four.	misc
	D. Manhattan calling the Mobile Command Vehicle, K. Manhattan calling Mobile Command Vehicle, K.	misc
	F. Engine 2-3-0 to Manhattan.	misc
	D. Two-three-zero, go ahead.	misc
	F. ...	misc
	D. All right, 10-4. You're in front of the 2 World Trade Center. Bring all your extra S.D.B.A.'s to the front of the building with you, K. Respond to West and Liberty and see Chief Barbera, K.	tk
		coa
	F. Ten-four, K.	misc

9:21	F. ... 2 to Manhattan.	misc
	D. Unit calling Manhattan.	misc
	F. ... 2 to Manhattan.	misc
	D. Go ahead.	misc
	F. Manhattan, do you have any special instructions.	itk
	D. What unit was this again, K?	itk
	F. Ladder 1-3-2 to Manhattan. Do you have any special instructions?	itk
	F. ... to Manhattan.	misc
	F. Field Comm. to Manhattan, K.	misc
	D. Field Comm., go ahead.	misc
	F. ...	misc
	D. All units in Manhattan, standby for a ... message. Go ahead, Field Comm.	misc
	F. ... [roaring interference]	misc
	D. Ten-four.	misc
9:22	F. Fourth Battalion to Brooklyn.	misc
	F. Staten Island to Manhattan.	misc
	D. All right, all units standby unless urgent. Manhattan to Mobile Command Unit. Manhattan to Field Comm., urgent.	rta
	F. Go ahead, Manhattan. Field Comm.	misc
	D. All right, Field Comm. No. 1 World Trade Center, the 1-0-3 floor, southwest corner and northwest corner, reported to be 100 people overcome at that location. Repeating, No. 1 World Trade Center, 103rd floor, northwest [interference] corner, reported to be 100 people in that location. Also, Ladder 3 is reporting on the 35th floor going up on the stairwell they've got numerous injuries, treating numerous injuries from burns occupied in the stairwell at this time. Field Comm. receive.	ct
	F. [inaudible]	misc
9:23	F. Field Comm. to Manhattan, K.	misc
	D. Field Comm., go ahead. Unit calling Manhattan.	misc
	F. Engine 5-0 is on ... Street.	tk
	D. Engine 5-1, 10-4.	misc
	F. Ladder 4-7 to Manhattan.	misc
	D. Ladder 4-7.	misc
	F. ... relocated to Ladder 6.	tk
	D. Ten-four. Unit calling?	itk
	F. ...	itk
	D. Unit calling, you're unreadable. What's your message? All right, any other unit calling?	itk
	F. Battalion 8 to Manhattan.	misc
	F. ...	misc
	D. All units, standby.	rta
	Battalion 8, you proceed.	coa
	F. Battalion 8. Which tower are we assigned?	itk
	D. Battalion 8, you're going into No. 1 World Trade Center, K. No. 1 World Trade.	itk
9:24	F. Battalion 8. 10-4.	misc
	D. Another unit calling Manhattan?	misc
	F. Brooklyn to Manhattan.	misc
	D. Brooklyn unit calling Manhattan.	misc

	F. Brooklyn Dispatch. Urgent, people trapped, 5 World Trade on the 8-0 floor; 3 World Trade, that's the 1-0-1 floor and the 1-0-2 floor. Manhattan receive?	cu
	D. That's a 10-4. Receive and acknowledge.	cu
	F. Ten-four.	misc
	D. Manhattan to Field Comm. Manhattan to Field Comm., urgent. Manhattan to Field Comm.	misc
	F. Division 1-1 to Manhattan.	misc
	D. Division 11.	misc
	F. Yeah, do you have a message for Field Comm.?	itk
9:25	D. Ten-four.	itk
	We've got a report of people trapped No. 5 World Trade Center on the 8-0 floor; No. 3 World Trade Center trapped on the 1-0-2 and 1-0-1 floors at this time, K.	cu
	F. One-one, 10-4, 5 World Trade Center, the 8-0 floor; 2 World Trade Center, the 1-0-2 and 1-0-1 floor.	cu
	D. That's a 10-4, K.	misc
	F. Field Comm. received that Manhattan.	itk
	D. Ten-four, Field Comm.	itk
	F. Ladder 1-0-5 to Manhattan, K.	misc
	D. Ladder 1-0-5.	misc
	F. One-zero-five 10-84 at the box.	tk
	D. Ladder 1-0-5, 10-4.	misc
	F. Car 9.	misc
	F. Engine 2-2-9, 2-2-4.	misc
	D. All right, all units standby unless urgent. Manhattan to Division 1-1. Field Comm.?	rta
	F. One-one to Manhattan.	misc
	D. Division 1-1, No. 1 World Trade Center, the 1-0-6 floor, 100 people trapped at that location, K.	ct
	F. One-one, 10-4.	misc
9:26	D. Another unit calling.	misc
	F. Car 9 to Manhattan.	misc
	D. Car 9, your message.	misc
	F. Present Chief Barbera, have all of the units responding to No. 2 World Trade Center, report in in front of No. 1 World Financial Center, which is on the corner of West and Liberty. All units coming in to No. 2 World Trade Center.	coa
	D. That's 10-4. Attention all units responding in to the fifth alarm No. 2 World Trade Center, you're to respond to No. 1 Financial Center, West Street and Liberty Street. Repeating, all units going in to No. 2 World Trade Center for the fifth alarm, you are to respond in to West Street and Liberty Street in front of No. 1 Financial Center. All units going in to the fifth alarm at No. 2 World Trade Center, you are to respond into West Street and Liberty Street. All units going into the fifth alarm for No. 2 World Trade Center, you are to respond to West Street and Liberty Street.	coa
	F. Ladder 1-9 to Manhattan.	misc
	D. Ladder 1-9.	misc
	F. One-four to Manhattan.	misc
9:27	D. Unit standby. Ladder 1-9, your message.	misc
	F. One-four to Manhattan.	misc

	F. Ladder 1-9 to Manhattan.	misc
	D. Ladder 1-9, you go. Ladder 1-9, your message.	misc
	F. Relocating to Ladder 16 on your frequency.	misc
	D. Ten-four, Ladder 1-4?	tk
	F. One-four can't respond into box 6-87 due to traffic. We're stuck by Water Street, the World Trade Center.	misc
	D. Ten-four.	tk
	F. Field Comm. calling Manhattan.	misc
	D. Field Comm.	misc
	F. Have M.S.U. activate all their spares and bring all their spares and all spare bottles to the scene of the fifth alarm, No. 1 World Trade Center, K.	coa
	F. Ladder ... to Manhattan.	misc
	D. All units stand down unless urgent. Field Comm., 10-4. Manhattan to Field Comm., K.	rta
	F. Field Comm., K.	misc
	D. Field Comm., No. 2 World Trade Center on the 8-3 and the 8-4 floors and the 8-2 floor, people trapped at this time.	cu
9:28	F. Ten-four.	misc
	D. Ten-four.	misc
	D. Any other unit calling Manhattan.	misc
	F. Engine 3-3-1 on your frequency.	misc
	D. Engine 3-3-1, 10-4.	misc
	F. Engine 2-1-6 to Manhattan.	misc
	F. Mayor's Service Unit to Manhattan.	misc
	D. Attention all units in the Borough of Manhattan, you are to standby unless urgent. All units in the Borough of Manhattan, standby unless urgent.	rta
	D. Attention all units, by the order of citywide tour commander, all off-duty firefighters and all off-duty officers are hereby recalled. Repeating, by the orders of the citywide tour commander, all off-duty firefighters and all off-duty officers, you are hereby ordered to recall immediately.	coa
9:29	F. Four Charlie to Manhattan, K.	misc
	D. Repeating, Manhattan announcing in the Borough of Manhattan, as per citywide tour commander, off-duty firefighters, all off-duty officers are hereby ordered for recall. Repeating, orders of the citywide tour commander, all off-duty firefighters and all off-duty officers, you are hereby ordered for recall.	coa
	D. Car Four Charlie.	misc
	F. Four Charlie responding. Is the Brooklyn-Battery Tunnel available in response to Manhattan, K?	itk
	D. Ten-four.	itk
	F. Ten-four.	itk
	D. ...	misc
9:30	D. All right. Any other unit with a message to Manhattan, K?	itk
	F. ...	misc
	D. One unit at a time.	rta
	Are any battalions calling? Any engine companies? Any ladder companies calling Manhattan?	itk
	Time is 09:30. Manhattan clear.	tk
	F. Marine 6 to Manhattan.	misc

	F. Car 9 to Manhattan.	misc
	D. Car 9.	misc
	F. Contact the units, fifth alarm, coming down for No. 2 World Trade Center, contact them individually and get them to acknowledge the fact that they are to come to Liberty and West, Liberty and West, K.	coa
	D. Car 9, 10-4. Marine 6?	misc
	F. Marine 6 to Manhattan, in the event of a transport problem into Manhattan we can establish a staging area at our quarters.	sa
	D. That's a 10-4.	misc
	F. ... to Manhattan, urgent.	misc
	D. Unit calling urgent, go.	misc
	F. ... 317 to Manhattan, urgent.	misc
	D. Engine 3-1-7, go.	misc
	F. I've got ... from the Port Authority telling me that the elevators are on the 44th floor. Don't use them, they're about to come down.	sa
	D. Is that going to be for No. 2 or No. 1 World Trade.	itk
	F. Wasn't sure. I'd say go with both.	itk
9:31	D. Attention all companies operating at the fifth alarm for both World Trade Centers, the elevators, the Port Authority reports the elevators on the No. 4-4 floor are about to come down. All companies operating at No. 1 and No. 2 World Trade Center at the fifth alarm, do not use the elevators. They are about to come down as per the Port Authority on the No. 4-4 floor. Field Comm., receive that urgent? Manhattan to Ladder 2-1, K.	cmm
	F. Field Comm. to Manhattan.	misc
	D. Field Comm.	misc
	F. Repeat that urgent.	misc
	D. As per the Port Authority, the elevators on the No. 4-4 floor, that's 44, are about to come down. Keep all members out, No. 1 and No. 2 World Trade.	cmm
	F. Ten-four.	misc
9:32	D. Manhattan to Ladder 2-1. Manhattan to Ladder 4. Manhattan to Ladder 3-5. Manhattan to Ladder 2-5. Manhattan to Ladder 2-2. Manhattan to Engine 9-1. Manhattan to Engine 5-8.	misc
	F. Engine 5-8. We're on - as far as we can get to the scene. We're going to walk down.	tk
	D. Ten-four. You're going to West and Liberty, K.	coa
	F. Ten-four.	misc
	D. Engine 4-7. Engine 7-6. Engine 7-4. Ladder 2-4. Ladder 7. Ladder 1-1-8. Ladder 1-2. Engine 2-1-4. Engine 2-1-8. Engine 2-1-6.	misc
9:35	FIELD (F). Engine 9-4 to Manhattan, K.	misc
	DISPATCH (D). All right, all units standby unless urgent. Manhattan calling Field Comm., K. Manhattan calling Field Comm.	rta
	F. Field Comm. Go ahead, Manhattan.	misc
	D. All right, Field Comm., you ready to write?	itk
	I got four for you to check in both building one and building two, everything we have up to now.	tk
	F. Give me building one.	itk

	D. O.K., building one: 9-2 floor; the 106th floor, the 89th floor; the 104th floor; the 100th floor; the northeast side; the 8-8 floor; the eighth floor, east side; the 105th floor; the 68th floor; the 106th floor northwest; 103rd floor, room 1-0-3; 83rd floor, room 8-3-11. Let me know when you're ready for building two.	tk
9:36	F. Proceed with building two.	itk
	D. O.K. The 82nd floor, west side; the 88th floor; 89th floor; 73rd floor, west side; 105th floor, east side; 104th floor, east side; 47th floor; 73rd floor, west office; 83rd floor, room 8-3-0-0; and 80th floor, northwest. That's what we have at this time.	tk
	F. Field Comm. received.	itk
	F. Squad 4-1 to Manhattan.	misc
	D. Squad 4-1, standby.	misc
9:37	D. Manhattan announcing, as per the citywide tour commander, all off-duty firefighters and all off-duty officers, you are to report to your sector stations and await further instructions. Repeating, all off-duty firefighters and all off-duty officers, you are to report to your respective stations and standby waiting for further orders. Manhattan announcing, all off-duty firefighters and all off-duty officers, you are to sector stations for a total recall and await further instructions. As per the citywide [interference], all off-duty firefighters and all off-duty officers you are hereby total recalled, you will report to your sector stations and standby. Squad 4-1, your message.	coa
	F. Marine Squad 18's response [area?] Do you want us to respond to Tower No. 2?	itk
	D. Standby.	itk
	F. Mass [Mayor's?] Service Unit to Manhattan.	misc
	D. All right, Mass Service Unit.	misc
	F. Mass Service Unit, 10-84 at the box.	tk
	D. Mass Service, 10-4.	misc
	F. Squad 4-1 to Manhattan.	misc
	D. Yeah, Squad 4-1.	misc
	F. I didn't hear your reply on the last message.	itk
9:38	D. All right,	itk
	at this time go ahead and respond to No. 2 World Trade.	coa
	F. Ten-four, responding.	itk
	F. Car 9 to Manhattan.	misc
	D. Car 9.	misc
	F. By orders of Chief Barbera [sp?], we want a second alarm assignment from Brooklyn to respond to Albany and West Street. A second alarm assignment from Brooklyn to respond to Albany and West Street through the Brooklyn-Battery Tunnel, no other route, and report to Chief Barbera at that location.	coa
	When you get the I.D. of the companies, give them to me, K.	itk
	D. Car 9, 10-4.	itk
	F. ... to Manhattan.	misc
	D. All units standby.	rta
9:39	F. Rescue 5 to Manhattan.	misc
	F. One-two-four to Manhattan.	misc
	F. Engine 7-1 to ...	misc
	D. Engine 7-1.	misc
	F. ...	misc

	D. Engine 7-1, your message?	itk
	F. We're on the Manhattan frequency.	itk
	D. Ten-four, make yourself ... Unit calling Manhattan.	rta
	F. Rescue 5 to Manhattan.	misc
	D. Rescue 5.	misc
	F. ... on your frequency.	tk
	D. Rescue 5, 10-4, make yourself available, K.	rta
	F. One-two-four to Brooklyn.	misc
	D. All right, Manhattan to Rescue 5, K.	misc
	F. Rescue 5, 10-8 Manhattan.	misc
	D. Rescue 5, you're to respond in to No. 1 World Trade Center. Rescue 5.	coa
	F. Rescue 5, 10-4.	misc
	F. Ladder 1-2-4 and 2-5 to Manhattan.	misc
	D. Ladder 1-2-5.	misc
	F. Ladder 1-2-4 is a couple blocks away.	tk
	D. All right, Ladder 1-2-4 standby.	rta
9:40	F. Ladder 4-3 to Manhattan.	misc
	D. Ladder 4-3.	misc
	F. ... is a 10-37. We're below 42 ... south, K.	tk
	D. All right Ladder 4-3, at this time make yourself available, stay in service, we'll notify you.	coa
	F. Ten-four.	misc
	F. ... Manhattan.	misc
	D. Ladder 5-9.	misc
	F. We responding to a relocation at 10 Truck, K.	tk
	D. Ten-four. Ladder 5-9, make yourself available, K.	coa
	F. Ten-four.	misc
	D. Any other unit calling Manhattan.	misc
	F. ...	misc
	D. All right, everybody standby. Engine company calling.	rta
	F. Engine 83 to Manhattan. What is the location of the station ... on Third Avenue?	itk
	D. Engine 8-3, standby.	itk
	F. Ten-four.	itk
	D. Manhattan to Field Comm., K.	misc
	F. Field Comm., K.	misc
	D. Field Comm. Building two, floor 1-0-3 and floor 9-3, floor 1-0-3 and floor 9-3. Acknowledge.	tk
9:41	F. Field Comm., 10-4.	misc
	F. Engine 4-3 to Manhattan.	misc
	D. Engine 4-3.	misc
	F. ... available in Engine 4-4's response area, K?	itk
	D. Ten-four.	itk
	D. Manhattan to Engine 8-3.	misc
	F. Engine 8-3.	misc
	D. Engine 8-3, what's your present assignment?	itk
	F. We're reporting to station ... Third Avenue. What's the cross street there?	itk

	D. Standby.	itk
	F. Engine 8-2 to Manhattan.	misc
	D. All right, Engine 8-3 standby now. Engine 8-2.	rta
	F. Engine 8-2, ... Engine 5-8's response area.	tk
	D. Engine 8-2, make yourself available.	coa
	F. Ten-four.	misc
	D. Manhattan calling Field Comm., K, with an urgent. Manhattan calling Field Comm. with an urgent, K.	misc
	F. Receive Manhattan, Field Comm.	misc
9:42	D. All right. Male hanging from a window near the antennae in building one.	tk
	F. Floor number?	itk
	D. Probably be up on the top floor, K.	itk
	F. Ten-four.	itk
	D. 09:42	misc
	D. Manhattan to Engine 8-3.	misc
	F. Engine 8-3.	misc
	D. Engine 8-3 you're to respond to [coordinates?] Engine 3-5. You're going to the deployment area, K.	coa
	F. Ten-four.	misc
	D. All right, any other unit calling Manhattan.	misc
	F. ... 4-6 to Manhattan.	misc
	D. Ladder 4-6.	misc
	F. ... responding to Ladder 2 for a relocation.	tk
	D. Ten-four. Ladder 4-6, make yourself available, K.	rta
	F. ...	misc
	F. ...	misc
	D. Unit calling?	itk
9:43	F. Ladder 6-4 switching over to Queens frequency.	tk
	D. Ladder 6-4 you're Manhattan frequency, K.	tk
	F. Car 4 David to Manhattan.	misc
	D. Car 4 David.	misc
	F. Got a report of a hanging antenna on the roof of building one?	itk
	D. Report of a male hanging from the antenna on building No. 1, K. One person hanging from the antenna.	itk
	F. Ten-four.	itk
	D. 9:42.41.6	misc
	F. Squad 2- ... to Manhattan, K.	misc
	D. Squad 2-8-8.	misc
	F. Fire Monster[?] Squad 2-8 on the Bronx to Manhattan, K.	misc
	D. Fire Monster Squad, go.	misc
	F. Where's the command post, K?	itk
	D. Command post for No. 2 World Trade Center, West Street and Liberty Street.	itk
	F. Ten-four.	itk
9:44	D. Other units calling Manhattan.	misc
	F. Ladder 1-4 to Manhattan.	misc
	D. Ladder 1-4.	misc
	F. Ten-8 in 24's response area, K.	tk

	D. Ten-four.	misc
	D. Any other unit calling?	itk
	F. Car 9 to Manhattan.	itk
	D. Car 9, go ahead.	misc
	F. I need the I.D. of that second alarm assignment and	itk
	make sure you tell them through the Battery Tunnel.	coa
	D. Car 9, they have been notified, K. It's in the process. Standby one minute.	itk
	F. Thank you, Manhattan.	misc
	F. Nine David to Car 9.	misc
	CAR 9. Nine David, K.	misc
	F. Ready to write these?	itk
	CAR 9. Nine David, go ahead.	itk
	F. Are you ready to write the identity?	itk
	CAR 9. Go ahead.	itk
9:45	F. Engines 2-4-0, 2-0-1, 2-4-9, 2-7-8, 2-8-1, 2-2-8, 2-1-9, 2-8-0. Your four truck companies will be 1-0-2, 119, 114, 113. The chiefs I gave you would be the 3-2, the 4-1 and the 4-2. All coming through the Battery Tunnel. I'm not identifying any [fast?] truck. If you want a fifth truck let me know and we'll send you one.	itk
	CAR 9. That's a negative. That last engine was 2-1-0?	itk
	F. Negative. 2-8-1.	itk
	CAR 9. K, thank you.	itk
	F. Ten-four.	itk
	F. Ladder 2-3 to Manhattan.	misc
	D. Ladder 2-3.	misc
	F. Ladder 2-3 is in Ladder 4's response area.	tk
	D. Ten-four.	misc
9:46	D. 9:46.41.2.	misc
	D. Manhattan calling Field Comm., K.	misc
	F. Manhattan calling Field Comm. Correction. Field Comm. calling Manhattan.	misc
	D. All right, on the 8-0 floor, northwest corner, 50 people trapped, K. That's in building one.	tk
	F. ... Manhattan, K.	misc
	D. 09:46.	misc
	F. Field Comm. to Manhattan.	misc
	D. Go ahead, Field Comm.	misc
	F. ... to Field Comm.	misc
	FIELD COMM. By orders of Chief Ganci, transmit an additional fifth alarm, have the additional fifth alarm units respond into West and Vescey, West and Vescey, K.	coa
	D. Ten-four. Authority Chief Ganci, fifth alarm, West and Vescey.	misc
	F. Ten-four.	misc
	D. Ten-four.	misc
	D. 09:47.	misc
9:47	F. Engine 1-4 to Manhattan.	misc
	D. Engine 1-4.	misc
	F. Are we assigned to the World Trade Center ...	itk
	D. Engine 1-4, standby, K.	itk
	D. Manhattan calling Field Comm., K. Manhattan calling Field Comm., K	misc

	F. Field Comm., K.	misc
	D. O.K., Field Comm., 104th floor, northwest corner, 50 people trapped, the fire's burning beneath them, K.	tk
	F. Hundred and fourth floor, northwest corner, what building?	itk
	D. That's building one, K.	itk
	F. Ten-four.	misc
	D. Manhattan to Division 3 messenger band, K. Manhattan to the Division 3 messenger band. Manhattan to Field Comm., K.	itk
9:48	F. Field Comm., K.	misc
	D. Field Comm., we're unable to raise the Division 3 messenger band regarding the extra handy walkie-talkies, K.	tk
	F. Ten-four.	misc
	D. Manhattan calling Field Comm.	misc
	F. Field Comm., K.	misc
	D. All right. Building two, building two, 80th floor, ... people trapped.	tk
	F. What floor?	itk
	D. Eight-zero, 8-0 floor in building two, 80 people trapped.	itk
	F. Eight-zero floor, 10-4.	itk
	F. ... to Manhattan.	misc
	D. Unit calling Manhattan.	misc
	F. Car 5 to Manhattan.	misc
	D. Car 5.	misc
	F. What's the location of the staging area?	itk
	D. Car 5, No. 2 World Trade Center is going to be West Street and Liberty Street, K.	itk
9:49	F. Ten-four. Thank you.	itk
	D. Another unit calling Manhattan. Time 09:48.4.12.	misc
	F. Engine 2-2-8 to Manhattan, K.	misc
	D. Engine 2-2-8.	misc
	F. I need a frequency, K,	itk
	responding to box 5-0, K.	tk
	D. Ten-four. Engine 2-2-8, you're coming through the Brooklyn-Battery Tunnel, 10-4.	tk
	F. Negative, Brooklyn Bridge, K.	itk
	D. That's a negative.	itk
	You're being redirected. You respond through the Brooklyn-Battery Tunnel and respond to the staging area, Albany Street and West Street. Engine 2-2-8.	tpr
	F. Two-two-eight, 10-4, K.	misc
9:50	D. Manhattan to Engine 2-4-0.	misc
	F. Two-four-zero, K.	misc
	D. Engine 2-4-0, you're responding through the Brooklyn-Battery Tunnel?	itk
	F. K, we were told to respond to West Street and Albany, K.	itk
	F. Three-zero-five to Manhattan.	misc
	D. All units standby unless urgent.	rta

	Attention the following units: Engine 2-4-0, Engine 2-0-1, Engine 2-2-8 acting, Engine 2-1-9, Engine 2-8-0, Ladder 1-1-3, Ladder 1-1-4, Battalion 3-2. All companies, you are to respond through the Brooklyn-Battery Tunnel, respond to the staging area, Albany and West Street, and meet up with Chief Barbera [sp?]. Repeating, Engine 2-4-0, Engine 2-0-1, Engine 2-2-8 acting, Engine 2-1-9, Engine 2-8-0, Ladder 1-1-3, Ladder 1-1-4, Battalion 3-2. All units you are to respond through the Brooklyn-Battery Tunnel. You're to respond in to Albany and West Street. Ask for Chief Barbera.	coa
	Engine 2-4-0?	itk
9:51	F. Two-four-zero, 10-4	itk
	and 10-84.	tk
	D. Engine 2-0-1? Engine 2-2-8?	itk
	F. ... 2-8, K.	itk
	D. Responding through the Brooklyn Tunnel, 10-4?	itk
	F. That's affirmative, K, 10-4.	itk
	D. Engine 2-1-9?	itk
	F. Two-one-nine, 10-4.	itk
	D. Engine -	misc
	F. One-one-four in to Manhattan, K.	misc
	D. Engine 2-8-0? Engine 2-8-0? Ladder 1-1-4?	misc
	F. One-one-four is in Manhattan frequency, responding in to box 5-0, K.	tk
	Have any special instructions?	itk
	D. Ten-four.	itk
	You're to go through the Brooklyn-Battery Tunnel, respond to Albany and West Street. Ten-four?	tpr
	F. Ten-four. Just where is Albany and West Street in relation to the towers, K?	itk
9:52	D. Ladder 1-1-3? Battalion 3-2? Engine 2-0-1? Time 09:52.41.6.	itk
	D. Manhattan calling Field Comm.	misc
	F. Field Comm., K.	misc
	D. Building two, 100th floor, northwest conference room, people trapped.	tk
	F. ... two, 100th floor, northwest conference room, 10-4.	tk
	D. Ten-four. 09:5 ...	misc
	F. Engine 3-7-1 ... Engine 6 to Manhattan.	misc
	D. Three-seven-one, go ahead.	misc
	F. ...	misc
	D. Ten-four.	misc
9:53	F. ... 7-4 to Manhattan, K.	misc
	D. Seven-four.	misc
	F. Coming into Manhattan, we're at Randall's Island, now picking up the ... K.	tk
	D. Ten-four. Time 09:5 ...	misc
	F. Ladder Company 1-7 to Manhattan.	misc
	D. One-seven.	misc
	F. One-seven's coming ... West Side ...	tk
	D. Ten-four.	misc
	D. Manhattan to Battalion 3-2. Manhattan to Battalion 3-2. Manhattan to Engine 2-0-1. Manhattan to Engine 2-0-1. Manhattan to Ladder 1-1-3. Manhattan to Ladder 1-1-3. All right, any other unit calling Manhattan.	itk
	F. Ladder 5-9 to Manhattan.	itk

	D. Ladder 5-9.	misc
9:54	F. We're unable to get to 10 Truck. We're in front of 140 Park Place.	tk
	D. All right, Ladder 5-9 standby where you are. Make yourself available, K.	rta
	F. Ten-four.	misc
	F. Three-zero-five to Manhattan.	misc
	D. Engine 3-0-5.	misc
	F. We're on your frequency.	tk
	D. Ten-four. Engine 3-0-5 make yourself available, K.	rta
	D. Manhattan to Engine 2-0-1, K, Engine 2-0-1. 09:54.41.	misc
	D. Manhattan calling Field Comm., K.	misc
	F. Field Comm., K.	misc
9:55	D. O.K., 86th floor, building one, room 8-6-1-7, people trapped. Also in building two, 97th floor, we have six people trapped.	tk
	F. Field Comm., 10-4.	misc
	F. Four-five to Manhattan.	misc
	D. Ladder 4-5.	misc
	F. ... all the Queens units coming through the tunnel to respond to the box?	itk
	D. Standby.	itk
	F. Engine 2-0-1 to Manhattan.	misc
	D. Engine 2-0-1.	misc
	F. You got a message for us?	itk
	D. Engine 2-0-1, you're to go through the Brooklyn-Battery Tunnel, respond to Albany and West Street. Engine 2-0-1?	itk
	F. Engine 2-0-1, 10-4.	itk
	D. Manhattan to Car 9.	misc
	F. Car 9, K.	misc
	D. Car 9, be advised the third fifth alarm for box 2-0-3-3 is going to be transmitted. I have 13 engines so far and six trucks and three battalions responding to various staging points.	tk
	Are you ready to write the identities?	itk
9:56	F. Go ahead, Manhattan.	itk
	D. All right. You're going to get Engines 2-5-8, 2-5-9, 3-2-5, 2-6-2, 3-1-2, 2-6-1, 2-6-0, Engines 6-8, 3-5, 5-0, 6-4, 9-4 and 8-3. I gave you three chiefs, the 4-5, the 4-6 and the 4-9. I owe you seven more engines, we're in the process.	tk
	F. All right, Manhattan. Thank you very much.	misc
	D. That box will be 2-0-3-3, Steve.	tk
	F. Engine 5-0, 10-4.	misc
	F. Engine 2-7-1, acting engine fixed to Manhattan.	tk
	D. All units standby. Manhattan to Field Comm., urgent.	rta
	F. Receive Manhattan, Field Comm.	misc
		rta
9:57	D. Tower No. 2, 19th floor, firefighter down. Tower No. 2, 19th floor, firefighter down.	
	F. Field Comm. received.	misc
	D. All right, all units standby in Manhattan unless urgent.	rta
	D. Manhattan calling Field Comm., K.	misc
	F. Field Comm., K	misc
	D. Building two, 93rd floor, northwest corner. Also in building one, 93rd floor, southwest corner, K.	tk

	F. Field Comm. received.	misc
	D. All right, I also have the 2 World Trade, 1-0-5 floor, 60 people.	tk
	F. Ten-four.	misc
	F. Engine 2-7-1 acting to Manhattan.	misc
	D. ...	misc
	F. Two-seven-one acting. We're a couple blocks away.	tk
	You want to give us a box ... take it in?	itk
	D. What unit is this again?	itk
	F. Engine 2-7-1 acting Engine 6.	itk
	D. All right Engine 2-7-1, make yourself available at this time.	itk
	F. Yeah, we're available, we're a couple blocks away.	tk
	Do you want us to take it in?	itk
9:58	D. Engine 2-7-1 standby.	rta
	D. Manhattan calling Field Comm., K. Manhattan calling Field Comm. Manhattan calling Field Comm.	misc
	F. ... to Manhattan, urgent.	misc
	D. Go ahead, K.	misc
	F. One of the buildings, the entire building has collapsed ...	imm
	D. ... urgent, identify.	itk
	F. ... major collapse in one of the towers.	imm
	D. Which tower, K?	itk
	F. Tower 2, Tower 2.	itk
	F. The entire tower, major collapse.	tk
	D. Ten-four.	misc
9:59	D. Manhattan to Field Comm., K. Manhattan to Field Comm.	misc
	F. Marine 6 to Manhattan.	misc
	D. Standby. Manhattan to Field Comm. Manhattan to Field Comm.	misc
	F. Marine 6 to Manhattan, urgent.	misc
	D. Marine 6.	misc
	F. Tower 2 has had a major explosion and what appears to be a complete collapse surrounding the entire area.	imm
	D. Marine 6, 10-4. We were notified, K.	cmm
	D. Manhattan to Field Comm., K. Manhattan to Field Comm.	misc
	F. ...	misc
	D. Attention 68 Engine, 35 Engine, 50 Engine, 64 Engine, 94 Engine, 83 Engine. Those units going to the fifth alarm box 2-0-3-3, we've been advised the West Side Highway has been opened to emergency traffic. The West Side Highway is open to emergency traffic. Take that route going to West and Vescey. Acknowledge 68.	tk
	F. Ten-four.	misc
	D. Thirty-five. Thirty-five engine.	misc
	F. Ten-four, 35.	misc
	D. Fifty.	misc
	F. Five-zero, 10-4.	misc
	D. Sixty-four.	misc
	F. Six-four, 10-4.	misc
	D. Ninety-four.	misc
	F. Nine-four, 10-4.	misc

	D. Eighty-three.	misc
	F. Eight-three, 10-4.	misc
	D. Manhattan calling Field Comm., K.	misc
	F. Engine 240 to Manhattan.	misc
	D. Go ahead 240.	misc
	F. There's been a major collapse to the tower. The command center ... everybody ... There was a major collapse. I'm in my ... right now.	tk
	D. Ten-four. We've notified them that there is a major collapse in the area, K.	cmm
10:00	F. Everybody in the area had to run. I don't know if Field Comm. is available.	tk
	F. Can anybody hear me?	itk
	D. Go ahead.	itk
	F. I'm a civilian. I'm trapped inside one of your fire trucks underneath ...	rta
	D. Standby, there's ... close to you.	tk
	F. I can't breathe much longer. Save me! I'm in the cab ...	rta
	D. Transmitting a mayday. Where are you, K.	itk
	F. I just told you.	itk
	It's north of the World Trade Center, there's the north ... bridge.	tk
	I think it collapsed when the partial building just collapsed. I was on the street ...	imm
	Please, help me!	rta
	F. ... I copy that. I'm going to go look for her.	tk
	D. Ten-four.	misc
10:01	D. Manhattan to Field Comm., urgent, K.	misc
	F. I can barely breath. Please, send somebody.	tk
10:02	D. O.K., the person calling for help, listen to me, you need to calm down and relax. Standby, we do have somebody on the way. You're to maintain air - get off the air. We do have somebody on the way over to you. You're to remain calm, 10-4?	coa
	F. It's falling on top of the truck.	tk
	D. Ten-four. We do have people on the way over there.	tk
	D. Manhattan to Field Comm., urgent, K.	misc
	F. ...	misc
	D. Standby. Manhattan to Field Comm., urgent.	misc
	F. ...	misc
	D. Manhattan to Field Comm.?	misc
	F. Field Comm. to Manhattan, urgent.	misc
	D. Field Comm., go.	misc
	F. ...	misc
	D. Manhattan to Division 1-1.	misc
	F. ...	misc
	D. Any other units calling Manhattan.	misc
	F. ...	misc
	D. Manhattan to Field Comm., K.	misc
10:03	F. George, have them mobilize the Army. We need the Army in Manhattan.	coa
	D. All units, standby. Everybody try to calm down. Manhattan to Field Comm., K. Manhattan to Division - Manhattan to - Manhattan to Car 9, urgent. Manhattan to Car 9, urgent. Manhattan to any unit operating at the fifth alarm, West Street and Liberty, for Tower No. 2. Any unit, K.	rta
	F. ...	misc

	D. Any unit operating at No. 2 World Trade Center at the collapse, contact Manhattan by radio forthwith.	coa
	F. Three-three Bravo to Manhattan, urgent.	misc
	F. Four-fifteen to Manhattan.	misc
10:04	D. Car 3-3 Bravo. We understand there's a major collapse.	cmm
	Can you give us some kind of report, K?	itk
	F. Four-fifteen to Manhattan.	misc
	D. Ladder 1-5, go.	misc
	F. Four-fifteen to Manhattan.	misc
	D. Ladder 15, go ahead.	misc
	F. This is an E.M.S. worker. There's been a major collapse.	tk
	We need additional units forthwith.	coa
	D. Ten-four. We have multiple units on the way in.	tk
	Ladder 1-5, can you ascertain if Field Comm. is part of the collapse, K?	itk
	F. Ladder 1-5 to Manhattan. Be advised, I'm not a ..., I'm an E.M.S. ...	tk
	D. Ladder 1-5, standby. Manhattan to any unit at No. 2 World Trade Center. Manhattan to any unit operating at No. 2 World Trade Center, urgent.	misc
	F. E.M.S. Ladder 1-5.	misc
	D. Ladder 1-5, Manhattan.	misc
10:05	F. ...	misc
	D. I want you to go to the nearest chief, Fire Department chief and have him come to the radio forthwith. If you find anybody with a white hat, get him to the radio. I need a report to find out what else I can send to him.	coa
	F. ...	misc
	D. All units standby unless urgent.	rta
	Is there a staff chief or a battalion chief trying to call Manhattan?	itk
	F. Ladder 15 to Manhattan -	misc
	F. ...	misc
	F. - be advised -	tk
	F. ... in the building, they're coming out now.	tk
	D. All right, all units standby.	rta
	Ladder 15 and Ladder 15 only, go ahead with your message.	coa
	Ladder 15, you have a message? What other unit calling Manhattan? What other unit calling Manhattan?	
	F. Battalion1, acting, calling Manhattan.	misc
	D. Battalion 1, go ahead.	misc
10:06	D. Yes, I want you to find a chief officer and have him come to this radio so I can find out what additional help I can send him.	coa
	You have three fifth alarm assignments and a second alarm assignment either at the scene or responding.	tk
	Let me know who's in command there at this moment.	itk
	F. Two-three-one, 10-4.	misc
	D. Do that forthwith ...	coa
	F. Two-three-one, K.	misc
	F. Ladder 1-2-4 to Manhattan.	misc
	D. Ladder 1-2-4.	misc
	F. We're at Church and West, we're at the scene of the collapse.	tk
	D. All right Ladder 1-2-4. Are you previously assigned to one of those boxes?	itk

	F. Negative. We picked it up as a ... we were acting Ladder 5. There are people all over the place.	itk
	F. ...	misc
	D. All units standby, please. Please, standby.	rta
	Other unit calling?	itk
10:07	F. Car 3 to Manhattan.	misc
	D. Two to Manhattan, go ahead.	misc
	F. We're on 57th and West Side Highway.	tk
	Let us go down West and get back to let you know what's going on.	rta
	D. What unit is this?	itk
	F. ... 3.	itk
	D. You're breaking up.	tk
	Who are you?	itk
	F. Ladder 4-3.	itk
	D. All right. I'm going to assign you to box 5-0 at West and Albany.	coa
	F. ...	misc
	F. ... to Manhattan.	misc
	D. All units please standby, one unit at a time.	rta
	What ladder company calling? What other unit calling?	itk
	F. Three Charlie.	misc
	D. Three Charlie.	misc
	F. Four Charlie, the operation is ... the command post is going to be set up on West Street, they're moving completely out to West Street.	tk
	D. All right. The command post is being consolidated, everybody's moving out to West Street.	tk
	Is that correct?	itk
	F. That's correct. I'm in contact with Chief ... and Commissioner Feehan and that's where we're going to start moving out, moving out of a further collapse zone.	itk
10:08	D. All right, 10-4.	misc
	D. Manhattan to Ladder 5-6. Calling Ladder 5-6.	misc
	F. ... to Manhattan.	misc
	D. ..., go.	misc
	F. ...	misc
	D. You're very low and scratchy, K, unreadable.	tk
	F. Fire Marshall Squad 2-8 to Manhattan or citywide.	misc
	D. Squad 2-8, go ahead.	misc
	F. We're moving some people, be advised, moving some people to the Chase Bank on Broadway.	tk
	We're setting up an ad hoc emergency ... post.	tk
	We need E.M.S. personnel, K.	kio
	We could use more people	kio
	because the place is filling up with injured.	tk
	D. Ten-four, we have multiple units on the way in at this time, K.	tk
	F. Ten-four.	misc
	D. All right, any other unit calling Manhattan.	itk
	F. Engine 2-8-6 to Manhattan.	itk
	D. Engine 2-8-6.	misc
	F. Acting Engine 10, we're going to respond right to the command post, K.	tk

	D. That's a 10-4.	misc
	F. Engine 4-5 to Manhattan.	misc
	D. Engine 4-5.	misc
	F. Engine 4-5's on your frequency, relocating Engine 3-5.	tk
	D. Engine 4-5, make yourself available, K.	rta
	F. Four-five, 10-4.	misc
10:09	D. All units calling Manhattan.	misc
	F. Marine 3 to Manhattan.	misc
10:10	D. Manhattan to Ladder 5-6, K. Ladder 5-6. Manhattan to Ladder 5-6. Manhattan to Ladder 5-6. Marine 3.	misc
	F. Marine 3, be advised, you need personnel on Marine 1. There's nobody in south ... vessel, K.	tk
	D. Ten-four.	misc
	F. Rudy Kelly [sp?] in Manhattan. Just tell everybody with their vessels to stand fast.	coa
	D. Marine 3, stand fast, K.	misc
	F. Marine 3, 10-4.	misc
10:13	D. 10:13.41.6.	misc
	F. Marine company.	misc
	F. Car 5 to Manhattan.	misc
	D. Car 5.	misc
	F. Any suggested routes from Midtown Tunnel to the command post?	itk
	D. On the West Side, West Side Highway's open. Brooklyn-Battery Tunnel would probably be your best route at this time.	itk
	F. I'm in Manhattan. I'll head over to the West Side Highway. Thank you.	itk
	F. Marine Company 9 to Manhattan.	misc
	D. Marine 9.	misc
	F. Did you have a problem with a marine company there? Did you need us for something?	itk
10:14	D. Marine 9, I don't know at this time. Standby.	itk
	F. Engine 2-2-8 to Manhattan, K.	misc
	D. Engine 2-2-8.	misc
	F. Would you inform the units ...	rcoa
	they were inspecting the Brooklyn-Battery Tunnel, the first cloud has subsided and the units can come through the tunnel now ... to proceed, K.	sa
	Are there any further instructions for Engine 2-2-8 at this time?	itk
	F. ...	misc
	D. Engine 2-2-8, at this time respond in to the command post West Street and Albany Street. Standby for instructions over there.	rta
	F. Engine 2-2-8, 10-4. Just put on the Manhattan frequency for the other units responding to the location that they can proceed through the tunnel, dust cloud on the Manhattan side has subsided, K.	sa
	D. Attention all companies responding to West Street and Albany Street for the second alarm, the Brooklyn-Battery Tunnel is now open.	tk
	The dust cloud has dissipated.	cmm
	All units can respond in to West Street and Albany Street for the second alarm for box 5-0. The dust cloud has subsided for the Brooklyn-Battery Tunnel.	tk
10:15	D. Manhattan to Field Comm., K. 10:15.41.6.	misc

	F. One-four to Manhattan.	misc
	D. One-four.	misc
	F. For responding companies, Seventh Avenue is wide open, clear.	tk
	D. Seventh Avenue is wide open?	itk
	F. Ten-four.	itk
	D. Ten-four. All units going in to the World Trade Center, be advised, Ladder 1-4 reports Seventh Avenue is wide open and also West Side Highway is open. All units going into the fifth alarm, West Side Highway is open and Seventh Avenue is open at this time as per Ladder 1-4. 10:15.41.6.	cmm
10:16	F. Car 5 to Manhattan.	misc
	D. Manhattan responding.	misc
	F. Advise the Queens unit that the bus lane heading into the Midtown Tunnel is wide open, the Port Authority has it all open for us both ways.	sa
	D. Ten-four. Attention all companies responding into Manhattan from the Queens side, Midtown Tunnel bus lane is wide open. All units responding into Manhattan from Queens, Midtown Tunnel bus lane is wide open. 10:16.4.16.	sa
	F. Engine 2-2-8 to Manhattan, K.	misc
	D. Engine 2-2-8.	misc
	F. Be advised, the tunnel is clear now ... we're trying to get to our staging area, Albany and West Streets, K, but we're encountering a lot of congestion, K.	tk
10:17	D. Ten-four.	misc
10:18	D. Any unit operating at No. 2 World Trade Center. Any unit operating at No. 2 World Trade Center, urgent. Any unit at No. 2 World Trade Center, urgent. Engine 2-2-8 acting. Engine 2-2-8 acting, K.	itk
	F. Manhattan dispatcher?	itk
	F. Can 2-2-8 10-5 your message?	itk
	F. We have a staging area just north of the north - just south of the North Cove Marina.	itk
	D. Ten-four. What unit is this?	itk
	F. Three Company One.	itk
	D. Three-One, standby. Manhattan to Engine 2-2-8.	misc
	F. Engine 2-2-8.	misc
	D. What's your location?	itk
	F. We just ... Battery ...	itk
10:19	D. All right, Engine 2-2-8 acting, is it possible you can get over to the Marriott Hotel, No. 2 World Trade Center? Firefighters trapped.	itk
	F. I don't think we can proceed with the lead, we'll go as far as we can. Marriott World Trade Center. Where are they trapped, K?	itk
	F. Unit calling, urgent.	misc
	D. Reported to be in a [fell?] area. Unit calling urgent.	itk
	F. We're in that - 2 World Trade Center. We have some of the individuals in the front. We're waiting to evacuate them, K.	tk
	D. All right, 10-4. Also be advised in the ... area at the Marriott Hotel receiving reports of firefighters trapped and down.	tk
	F. We'll work on that.	misc
	D. Ten-four.	misc
	F. Mobile Command Center to Manhattan, K.	misc
	D. Mobile Command Center, K.	misc

	F. Manhattan, can you contact Field Comm.?	itk
	D. Mobile Command Center, at this time we are unable to make contact, K.	itk
	F. Thanks a lot, Manhattan. I'll get back to you.	itk
	D. Ten-four. 10:20.41.6	misc
10:20	F. Squad 6-1 to Manhattan.	misc
	D. Squad 6-1.	misc
	F. On your frequency, responding to supporting team.	tk
	D. ...	misc
10:21	F. ... 9 to Manhattan, K.	misc
10:22	DISPATCH (D). Mobile Command Center, K.	misc
	FIELD (F). Mobile Command, K.	misc
	D. Mobile Command Center, this is an urgent message: We need to set up a relay communication, K, to find out exactly what's going on. We also have numerous calls reporting people trapped. Mobile Command Center?	rta
	F. Ten-four. Could you try and relay that to Car 9?	rta
	D. Manhattan to Car 9, K. Manhattan to Car 9, K. Mobile Command Center?	misc
	F. We're direct. You're unable to raise. We'll try and work out something from -	tk
	D. Ten-four.	misc
	F. Nine David to Mobile Command Vehicle. Nine David Unit to Mobile Command Vehicle.	misc
	F. Nine David, go ahead.	misc
	F. Yeah, as soon as you get - are you at the scene?	itk
10:23	F. They have us right now down opposite the Downtown Athletic Club on West Street.	itk
	F. Get me a status report on Car 9 and all the other units that were in that area. And get them direct to me on the telephone please.	rta
	F. Ten-four, 9 David. As soon as possible.	misc
	F. Ten-four.	misc
	F. Five [nine?]-one-seven to Manhattan. [Speculating?] a second piece to Manhattan, K.	misc
	D. Manhattan responding.	misc
	F. ... second piece responding with seven firemen and two officers to the scene of the fire, K.	tk
	D. Ten-four.	misc
10:24	D. Manhattan to Engine 2-0-2. Manhattan to Engine 2-0-2, K. Manhattan to Engine 3-0-9 acting, K.	misc
	F. Three-nine acting.	misc
	D. Engine 3-9 acting, report on the 22nd floor, reporting a floor collapse at that location, K.	tk
	F. Three-zero-nine acting, 10-4. We're the one on this box, correct?	itk
	D. At this time that's all we can send you, K.	itk
	D. Ladder 1-4-6 acting, receive.	misc
	F. One-four-six, 10-5.	misc
	D. At this time reporting a floor collapse on the 22nd floor.	tk
	You're going to have one ... response to the box at this time.	sa
	F. One-four-six acting, 10-4.	misc
	D. Manhattan to Ladder 5-6, K, Ladder 5-6. Manhattan to Squad 6-1 acting, K.	misc
	F. Six-one.	misc

10:25	D. Call in to box 6-3.	tk
	F. Ten-four.	misc
	D. Manhattan to Ladder 3, K. Manhattan to Ladder 3.	misc
	F. Engine 2-3-6 acting Engine 15 to Manhattan.	misc
	D. Two-three-six acting.	misc
	F. We can't get anywhere near our box 80,	tk
	make it a 10-33 and we're available to go to the job.	coa
	D. Ten-four, 2-3-6 at this time remain in service.	coa
	F. Ten-four.	misc
	F. Engine 5-2-1 to Manhattan, K.	misc
	D. Come in Engine 2-0-2, K. Come in Engine 2-0-2. Other unit calling Manhattan.	misc
	F. Four-seven acting Ladder 15 to Manhattan.	misc
	D. Unit acting Ladder 1-5.	misc
	F. We've got a 10-35 code 1, we're 10-8.	tk
	D. Ten-four. Stay in position and wait for further instructions.	coa
	F. Ten-four.	misc
10:26	D. Another unit calling Manhattan.	misc
	F. Engine 5-2-1 to Manhattan, K.	misc
	D. Engine 5-2-1.	misc
	F. Five-two-one special operations command messenger vehicle responding to Manhattan with 12 rescue firefighters.	tk
	D. Ten-four.	misc
	D. Manhattan to Ladder 3, K. Three truck? [10]:26.416. Any other unit calling Manhattan.	itk
	F. Forty Charlie to Manhattan.	misc
	D. Four-zero Charlie.	misc
	F. I don't know what you got to do, but I want all the rescue firefighters available from home to report, K.	coa
	D. Ten-four. We have been broadcasting that, K.	tk
	F. We need all the help we can get.	kio
	D. Ten-four. We have multiple units on the way in now.	tk
	F. Ten-four.	misc
10:27	D. Manhattan to Ladder 3, K. Ladder 3?	misc
	F. Three-three-one acting 2-1 to Manhattan, K.	misc
	D. Three-three-one.	misc
	F. We're going to respond in. We have recall firefighters.	tk
	Any particular place at this point?	itk
	D. Engine 3-3-1, standby. Manhattan to Engine 3-3-1, respond over to Engine 2-1 and standby for further instructions.	itk
	F. Ten-four.	misc
	D. Manhattan to Ladder 4-6 acting, K.	misc
	F. Mobile Command Center to Manhattan, K.	misc
	D. Mobile Command Center.	misc
10:28	F. Be advised, Mobile Command Center is set up in front of Pier A. I have Engine 2-0-9 with me. Also Dr. Prezant and Supervisor Fire Marshall Burns, K. I have no radio contact with anybody else at this time. As soon as I get something I'll let you know, K.	tk
	D. Ten-four Mobile Command Center.	misc

	F. Three-three to Manhattan urgent.	misc
	D. Three-three.	misc
	F. The other tower just collapsed! Major collapse, major collapse!	tk
	D. Ten-four on your urgent.	misc
	F. ...	misc
	F. Marine 3 to Manhattan, K.	misc
	F. ... to Manhattan.	misc
	F. Urgent, 2-8-9 to Manhattan, urgent. The World Trade Center collapsed. Building two has collapsed, K.	tk
	F. Urgent! Urgent!	misc
	D. Unit calling urgent, K.	misc
10:29	F. ... we had a collapse of the second tower. Everybody's running from there. This is ...	imm
	D. Ten-four. Attention all units, we're receiving reports that No. 1 and No. 2 World Trade Center collapsed. All units at the scene receiving reports, No. 1 and No. 2 World Trade Center, both towers collapsed.	cmm
	F. Engine 2-3-6 to Manhattan.	misc
	D. Manhattan responding.	misc
	F. Yeah, we're jammed down in the street over here.	kio
	We can't even move the car.	kio
	I'm leaving ... with the rig, I'm heading over that way.	tk
	D. Ten-four.	misc
	D. Any other unit calling. 10:30.41.6.	misc
10:30	F. Ladder 5-9 to Manhattan.	misc
	D. Ladder 5-9.	misc
	F. We're going to be severely delayed to 17 Battery Place. We're in heavy, heavy traffic, K.	tk
	D. Ladder 5-9, 10-4.	misc
	D. Manhattan announcing, any division or any staff chief at the scene of the World Trade Center, K? Any division chief or any staff chief at the scene of any of the World Trade Centers, K? Manhattan to Mobile Command Center, K.	itk
	F. Mobile Command to Manhattan, K.	misc
	F. Engine ... acting at the command post to Manhattan, K.	itk
10:31	F. Mobile Command Center to Manhattan, K.	misc
	D. Mobile Command Center, what chief do you have at your Mobile Command Center, K.	itk
	F. Negative on any chief, K.	itk
	Right now we're all alone.	tk
	The second building came down. I can't see. So we have no contact with anybody at this time, K.	imm
	D. Ten-four.	misc
	F. Division 6 acting Division 1, K.	misc
	D. Division 6 acting, K.	misc
	F. I'm in Division 1's area. Do you want me to respond down to the scene, K?	itk
	D. Division 6, that's a 10-4. Standby. Manhattan to Division 6.	itk
	F. Division 6 acting Division 1, on the West, we're heading down towards 1 and 2 World Trade Center now, K.	tk
	D. Manhattan to Division 6 acting, K, urgent.	misc

	F. Division 6 acting, go.	misc
	D. You are responding down to the World Trade Center, you are to maintain radio communication and advise Manhattan Dispatch what exactly is going on, K.	coa
	We are unable to make any kind of communication.	tk
	F. Ten-four.	misc
10:32	D. 10:32.41.6	misc
	F. Mobile Command to Manhattan, K.	misc
	F. This is ... 4 Alpha. We have dozens and dozens of firemen. We're at the bulkhead on the Hudson River side of the World Trade Center. We have medical emergencies. We have E.M.S. on the scene treating possible heart attacks. We're in the process of getting some kind of a roll call. We're going to try to keep the units together here, K.	csg
	D. Ten-four. Mobile Command Center.	misc
	F. Standby, Manhattan.	misc
	D. Ten-four. 10:32.41.6	misc
10:33	F. Four Alpha to Manhattan, K	misc
	D. Four Alpha.	misc
	F. We have a medical emergency, possible heart attack, firemen, we're on the bulkhead, west, requesting oxygen for the firemen, K.	rta
	Any unit that can hear me come to the bulkhead on the Hudson River side of the World Trade Center.	csg
	D. Ten-four.	misc
	F. ... need the oxygen.	misc
	D. That's at the bulkhead on the Hudson side of the World Trade Center, K. Receive?	itk
	F. ...	misc
	F. Engine 2-2-8 to Manhattan, K.	misc
	D. Engine 2-2-8.	misc
	F. Be advised, Manhattan, we're on West Street at the Battery Tunnel ... is starting to clear up, we're starting to see ... Give us time so we can report back to you for further instructions, K.	cmm
10:34	D. Engine 2-2-8, 10-4.	misc
	D. Manhattan to Mobile Command Center, K.	misc
	F. Battalion 1-6 to Manhattan.	misc
	F. Car 5 to Manhattan.	misc
	F. Battalion 1-6, we have ... Ladders 5 and 11 manned and ready. Have any instructions for us, K?	itk
	D. Standby.	misc
	F. Car 5 to Manhattan.	misc
	D. Car 5, go.	misc
	F. Did the command post establish at ... ?	itk
	D. Ten-five, K, you're breaking up.	itk
	F. Did command post establish a command [cell?] ... ?	itk
10:35	D. At this time we're unable, K. We're going to contact Mobile Command and see what we can do. Manhattan to Mobile Command Center. Manhattan to Mobile Command Center, K. Manhattan to Mobile Command Center.	itk

	F. Car 5 to Manhattan. I understand that the command post has been moved north of Vesey Street. I'm going up to Chambers and West and see if I can find out, find ... I'll talk to you when I get on the radio.	tk
	D. Car 5, 10-4.	misc
	F. Division 1 acting to Manhattan.	misc
	D. Division 1.	misc
	F. Everything south of the Brooklyn Bridge is in a dust cloud. There's no visibility, people all over the streets. Travel is near impossible.	cmm
	D. Ten-four Division 1.	misc
	F. ...	misc
	D. Manhattan to Engine 5-1-1, K. Manhattan to Battalion 1-6.	misc
10:36	F. One-six ... Manhattan. Battalion 1-6 responding.	tk
	D. Manhattan to Battalion 1-6, Engine 511's going to respond over to Engine 6-5's [quarters?] ...	tk
	F. Battalion 1-6, 10-4.	misc
	D. Unit calling Manhattan.	misc
	F. ...	misc
	D. Battalion 4-3. Manhattan to Battalion 4-3.	misc
	F. Battalion 4-6 to Manhattan.	misc
	D. Four-six, go ahead.	misc
	F. ...	misc
	D. Manhattan to Battalion 4-6, you're totally unreadable, K.	tk
	F. ...	misc
	D. Manhattan to Battalion 4-6, you're totally unreadable.	tk
	F. ...	misc
10:37	D. 10:37.416.	misc
	F. ... 4-8 ...	misc
	D. Division 6.	misc
	F. Division 6, K.	misc
	D. Disregard this message, K.	misc
	D. Ladder 4-6. Manhattan to Ladder 4-6, you message?	itk
	F. Ladder 4-8 to Manhattan.	misc
	D. Ladder 4-8.	misc
	F. We're stuck in heavy traffic, still in the Bronx, and I'm on your frequency.	tk
	D. Ten-four, Ladder 4-8.	misc
10:38	D. Time 10:38.416.	misc
	F. Reinforcement bus to Manhattan, we're on ...	tk
	F. Three-five-zero acting Engine 5 to Manhattan.	misc
	D. Standby. Reinforcement unit.	misc
	F. Two-five-zero acting Engine 5.	misc
	D. Engine 2-5-0 acting.	misc
	F. We're on the Manhattan side on the F.D.R. if you need us.	tk
	D. Ten-four, make yourself available, K.	coa
	F. Ten-four.	misc
	D. Manhattan to Engine 2-5-0 acting, K.	misc
	F. Two-five-zero acting.	misc
	D. Continue in, relocation to Engine 5's quarters.	coa
	F. Ten-four.	misc

10:39	D. 10:39.416.	misc
	D. Manhattan to Battalion 1. Manhattan to Ladder 8, K. Manhattan to Engine 2-6. Manhattan to Engine 2-6.	misc
10:41	D. 10:41.416.	misc
	F. Division 1 to Manhattan.	misc
	D. Division 1.	misc
	F. Broadway, Vescey Street, Fulton Street, heavy debris, a huge dust cloud, people all around.	imm
	We have not gotten to the scene yet, K.	tk
	F. Four Alpha to Manhattan.	misc
	D. Ten-four, Division 1. Car 4 Alpha.	misc
	F. This is Battalion 4 Alpha to Manhattan. Be advised we have New York waterway boats along the Hudson River bulkhead just north of the World Trade Center, K, for evacuations to hospitals in Jersey City. I have named at least one fireman taken in already. I'm keeping a list, K.	tk
	D. Ten-four, Car 4 Alpha.	misc
	F. Division ... to Manhattan.	misc
	D. Division calling Manhattan.	misc
	F. ...	misc
	D. Unit calling Manhattan you're totally unreadable, K.	tk
	F. ... if you can copy, command post ...	misc
	F. ...	misc
	F. ... Engine 5, Park Row.	misc
10:42	D. At this time all units standby unless urgent. All units standby unless urgent. The division trying to transmit, be advised you're totally unreadable. You're radio's not coming in, K.	coa
	D. Any unit calling Manhattan.	misc
	F. Division 1 acting to Manhattan. The command post is going to be set up at Park Row, south of City Hall at Vescey Street. It's the only place where we can, the dust cloud have relieved [possibly?].	sa
	D. All right. This is Division 6 acting Division 1?	misc
	F. Ten-four, Division 6 acting Division 1. The command post at this point will be Vescey Street and Park Row, south of City Hall, K.	tk
	Do you copy?	itk
	D. Division 6, that's a 10-4, K.	itk
	F. Have all incoming Fire Department units report to this location and stage on Park Row.	coa
	D. Division 6 acting, that's a 10-4, K.	misc
10:43	F. Division 6 acting again, the access down the F.D.R. is clear, P.D. has the F.D.R. lanes open. But have all units approach using extreme caution. Traffic is going the wrong way and numerous civilians, K.	tk
	D. Division 6 acting, 10-4.	misc
	F. Three-two-one acting to Manhattan.	misc
	F. ... to Manhattan.	misc
	D. Three-two-one to Manhattan.	misc
	F. We're in Engine 6's ... area.	tk
	D. Engine 3-2-1, what route did you take getting into Manhattan, K?	itk
	F. Car 5 to Manhattan.	misc

	D. Standby. Car 5, message.	misc
	F. Car 5, we're trying to establish a command post at Vescey and West.	tk
	Notify any department officials that's where we're trying to establish a command post.	coa
10:44	D. Car 5, 10-4. Car 5 be advised, as per Division 6 acting, they have set up a command post Park Row, south of City Hall by Vescey Street, and we're going to be redirecting units into Park Row ... K. Car 5, receive?	tk
	D. Attention all units responding in to the World Trade Center, be advised we are now receiving, we are now setting up a new command post, Park Row, south of City Hall by Vescey Street.	aro
	All units are responding to the new staging area on Park Row. Repeating, all units not presently committed, respond over the staging area, Park Row, south of City Hall on Vescey Street.	coa
	Be advised the F.D.R. Drive is now clear. You are to use extreme caution proceeding downtown in Manhattan. Time 10:45.416.	sa
10:45	F. Squad 6-1 to Manhattan.	misc
	F. Ladder 5-9 to Manhattan.	misc
	F. Do you want us to proceed to 150 Broadway or to the staging area?	itk
	D. Squad 6-1, standby. Ladder 5-9.	itk
	F. We're 10-84 at 17 Battery Park Place.	tk
	D. Ladder 5-9, 10-4.	misc
	F. ...	misc
	F. We have ... Mobile Command Post unit from Division 6. We're setting up on the corner of Ann Street and Broadway.	tk
	D. Division 6, that was Worth Street and Broadway, Mobile Command Center?	itk
	F. The new command post is set up there. We have a command post set up with a radio and we're going to be monitoring the frequency.	itk
	F. Car 5 to Manhattan.	misc
	D. All right, Division 6 acting, 10-4.	tk
	D. Car 5.	misc
	F. Car 5, have we been touch with Car 3 or Car 4?	itk
	D. Negative at this time, K.	itk
10:46	F. Did you get my previous message about West Street and Vescey?	itk
	D. Car 5, that's 10-4.	itk
	Be advised Division 6 reported the new staging area will be Park Row, south of City Hall on Vescey Street. We have notified units coming in that Park Row will be the new staging area. And we also have reports that the F.D.R. is clear at this time, use caution. Also Division 6 reporting ... the command post to monitor all radio frequencies at Worth Street and Broadway. Car 5?	cu
	F. Car 5 is on West and Vescey. We trying to establish a command post up here.	itk
	I've got E.M.S. and everybody at Vescey and West Street ... and we've got plenty of help with the E.M.S. people.	imm
	D. Car 5, that's going to be Vescey Street and West Street, K?	itk
	F. Vescey and West.	itk
	If you'll get Division 6 up here I'd love you.	rta
	D. Manhattan to Division 6 acting, K.	misc
	F. Two-four to Manhattan.	misc
	D. Engine 2-4 go.	misc

10:47	F. Two-four ... members out of the building. I've got two members trapped. I can't tell the command post. Two members trapped in the promenade between the two towers.	tk
	D. Ten-four.	misc
	D. Manhattan to Mobile Command Center.	misc
	F. Mobile Command Center, K.	misc
	D. Receive that report Engine 2-4 has firefighters trapped in the promenade?	itk
	F. We'll try to relay that message. Right now we're at the intersection of Battery and West.	tk
	F. ...	misc
	D. Attention all units, standby. Manhattan to Division 6, K.	rta
	F. Division 6 acting Division 1, go ahead.	misc
	F. ...	misc
10:48	D. Division 6 acting Division 1, be advised we have a mayday transported by, transmitted by Engine 2- ...	tk
	All units in the Borough of Manhattan, standby unless urgent.	rta
	Division 6 acting, Engine 2-4 transmitted a mayday, in the promenade they have firefighters trapped.	tk
	That's No. 1. No. 2, Car 5 is establishing a command post, West Street and Vescey Street.	tk
	He would appreciate it if you could respond over to that location and coordinate the efforts with him, K.	rta
	F. Division 6, 10-4. We have a command post set up at Vescey and Park Row on the corner. Vescey Street and Park Row.	tk
	D. Ten-four. We do have units coming into that staging area on Park Row, K. See if you can contact Car 5, K.	shk
	F. Ten-four.	misc
	D. Any other unit calling Manhattan.	misc
	F. Two-zero-nine to Manhattan.	misc
	D. Engine 209.	misc
	F. Yeah, Manhattan. We got over here. Where is our new staging area, K?	itk
	D. Engine 209, as per Division 6 - standby Engine 209.	itk
	F. Engine 33 to Manhattan, urgent.	misc
	D. Engine 209, go to Vescey and West Street, K.	coa
	F. Verify that Manhattan.	itk
10:49	D. You're going over to Vescey Street and West Street.	itk
	F. Ten-four, Manhattan. Thank you.	itk
	D. Engine 33 urgent, go.	misc
	F. Engine 33 is being manned by an off-duty member from Rescue 1.	tk
	Be advised it appears that we have lost water pressure down in lower Manhattan. Can you have Marine 1 or any other available fire boat respond to Vescey Street on the West Side? We're going to need water supply into the area, K.	tn
	D. Manhattan to Car 4-0 Charlie, K.	misc
	F. Marine Company 4, we're responding to Vescey Street.	shk
	D. Marine 4, 10-4.	misc
	F. Did you get that Manhattan?	shk
	D. Marine 4, 10-4. Engine 3-3, 10-4. We have Marine 4 responding over there.	shk
	F. O.K. thanks. I'm going to ...[wait?] for Marine. That's what we got for now.	shk

	D. Manhattan calling Car 5. Manhattan to Car 5. Manhattan to Division 6 acting for Division 1.	misc
10:50	F. Division 6, go ahead Manhattan.	,
	D. Did you copy that message about the water pressure and request for marine units to establish a water supply.	itk
	F. I received that message. Be advised, our command post is set up on Broadway and Park Row where Vescey Street is. You got that?	itk
	D. Ten-four. Are you going to take care of that message regarding the water supply?	itk
	F. We're right on Park Row, we're not down on Vescey Street.	itk
	F. Mobile Command to Manhattan.	misc
	D. Mobile Command if you can get in touch with Car 5 or any other staff people at the scene, advise them of the report of poor water pressure in lower Manhattan and the request for units to set up water supply using marine companies and/or satellite. And get back to us forthwith, please.	cmm
10:51	F. Mobile Command, 10-4, we will attempt to do so.	misc
	D. Ten-four.	misc
	F. Marine 6 Alpha to Manhattan, K.	misc
	D. Marine 6 Alpha, go ahead.	misc
	F. You're requesting water relay, over?	itk
	D. Marine 6 Alpha, are you located down at the Battery?	itk
	F. We're in the Brooklyn Navy Yard, over.	itk
	D. According to units at the scene, Marine 6 Alpha, they want to augment the water supply using marine companies. That's going to have to be coordinated through the staff chief at the scene.	sa
	F. Where is he located, over?	itk
	D. The staff chief is located at West at Vescey Street we believe.	itk
	F. ... Division, urgent.	misc
	D. Unit with an urgent, go ahead.	misc
	F. We've got numerous people trapped here from the previous collapse.	tk
	We need a hand to get them out, K.	coa
	D. Where are you?	itk
	F. We're about four feet under. I really don't know.	itk
	D. Where were you operating?	itk
	F. North Tower, K.	itk
	D. Tower No. 1 or Tower 2?	itk
10:52	F. No. 1.	itk
	D. Ten-four.	itk
	D. Calling the Mobile Command Vehicle. Calling the Mobile Command Vehicle, K.	misc
	F. Mobile Command, K.	misc
	D. I have an urgent message from ... we have contact with units that are trapped in the vicinity of the west side of Tower No. 1.	tk
	They're requesting urgent help.	coa
	F. Ten-four, on the west side Tower 1. That's contact Car 5, K?	itk
	D. ... Car 5 tell them that we have reported members who are trapped under debris.	itk
	F. Ten-four.	misc
	F. Battalion 1 to Manhattan, K.	misc

	D. Battalion 1, go ahead.	misc
	F. The recalls have just come in. Listen, I have about 15 people down in 415 right now.	tk
	Call them on the voice alarm, send them over to where you want them on that side.	coa
	Also if you can release 14 Engine, have them take a chauffeur and go up and pick up the spare apparatus. That was in our original plan, K.	tn
	D. We're working on that.	misc
	F. We do have about 15 firefighters right now in the quarters of 415, K.	tk
	F. ... Battalion.	misc
	D. Manhattan.	misc
10:53	F. Marine 6 to Manhattan, K.	misc
	D. Marine 6.	misc
	F. Be advised, the - as far as the marine resources go we have the two big fire boats, Marine 1 and Marine 9, on the West Side of Manhattan.	tk
	Have them rendezvous for the water supply.	coa
	We have Marine 6 and Marine 6 Alpha on the East Side. We're going to stay on this side of the smoke plume and see what we can handle on this side. If you have any further ... transport or other.	tk
	D. Ten-four.	misc
	D. Manhattan to Marine 1, K. Manhattan to Marine 1. Manhattan to Marine 9, K.	misc
	F. Marine Six Alpha to Manhattan, K.	misc
	F. Nine to Manhattan.	misc
	D. Marine 9, you go over to Vescey Street on the West Side. Establish a water relay, K.	coa
	F. Ten-four. Do you have a box assignment on this, box number? Because we at some point are directed to the Staten Island side so we're going to be heading over there now. Do we have a box number on this?	itk
10:54	D. Marine 9 responding into box 8-0-8-7, fifth alarm.	itk
	F. Marine ... Manhattan, we're on our way.	itk
	D. Marine 9, 10-4.	misc
	D. Manhattan to Marine 1, K.	misc
	F. One, K.	misc
	D. Marine 1, you're to respond over to Vescey Street on the West Side, establish a water relay. Marine 1.	coa
	F. We're 10-4. Be advised we have numerous injured people on board, babies and hundreds of people. So we might have to ... off our boat with another boat or something, K.	tk
	D. All right, Marine 1 that's a 10-4 ... assistance over there.	misc
	F?. We're right below the North Cove Marina about 100 yards. I'm not sure what street we're on, K.	tk
	D. All right, standby.	misc
	D. Unit with urgent, go.	misc
	F. Yeah, this is ... 6, I'm on the West Side Highway, I'm pinned. I can't seem to get out, K.	tk
	D. This is a firefighter from Marine 6?	itk
10:55	F. An officer from Marine Division, K.	itk
	D. You're on the West Side Highway or the west side of the building?	itk

	F. West Side Highway.	itk
	D. You're on the West Side Highway? Are you pinned in a piece of apparatus?	itk
	F. Ten-four.	itk
	D. All right, we're going to get some members over there to assist you.	itk
	D. Calling the Mobile Command Vehicle.	misc
	F. Marine 6 to Manhattan.	misc
	D. Go ahead.	misc
	F. The member you just spoke to is Captain Fuentes [sp?]. He is the Marine Division.	cu
	D. I'm trying to get him some help.	cu
	D. Calling the Mobile Command Vehicle.	misc
	F. Engine 2-8 to Central.	misc
	D. Two-eight Engine.	misc
	F. ... members trapped.	tk
	D. ... 2-8 Engine.	misc
	F. We're on the West Side Highway opposite the World Trade Center. We have Captain Fuentes trapped in a vehicle.	cu
	D. Ten-four.	cu
	F. Marine 6 Alpha to Manhattan, K	misc
	D. Six Alpha.	misc
	F. Where do you want us?	itk
	D. Six Alpha, where are you right now?	itk
	F. Brooklyn Navy Yard.	itk
	D. Sign out for lower Manhattan opposite the World Trade Center.	itk
	F. Six Alpha, 10-4, K.	itk
10:56	D. Calling Captain Fuentes.	misc
	F. Ladder 1-7 acting 1-5 to Manhattan.	tk
	D. One-seven acting 1-5.	misc
	F. We are ... as a unit in the quarters of Ladder 1-5 ...	tk
	D. Standby, one minute. I may have a run for you.	rta
	D. Calling Captain Fuentes.	misc
	F. Conway [?] calling Manhattan, K.	misc
	D. ... Manhattan.	misc
	F. This is Dennis [?] Conway [?]. At least ... engines down on ... We've got car fires that need ...	tk
	D. Unit transmitting, you're totally unreadable.	tk
	Everybody standby unless they have an urgent message. If there's an urgent message, go ahead.	rta
	F. ...	
	D. Unit, you're breaking up and tying up the frequency.	tk
	Go to another radio.	coa
10:57	F. Ladder 101 recall to Manhattan, K.	misc
	D. Standby 101.	misc
	D. Calling Car 4 Charlie, 4 Charlie. Calling the Mobile Command Vehicle.	misc
	F. ...	misc
	D. Standby. Calling the Mobile Command Vehicle. Calling the Mobile Command Vehicle. Calling Division 6 acting 1. Division 1, K, 6 acting 1. Calling the Mobile Command Vehicle.	misc

	F. ...	misc
10:58	D. Units, you're cutting each other off. I'm not reading you. Calling the Mobile Command Vehicle. Calling Division 6. Calling Car 5. Calling the Mobile Command Vehicle. Calling the Mobile Command Vehicle. Calling Car 5 or Division 6.	tk
	F. ...	misc
	D. Calling Car 4 Charlie.	misc
	F. ...	misc
10:59	D. Unit you're breaking up.	tk
	F. ... rescue ...	misc
	D. Go ahead.	misc
	F. I'm going to sleep [?].	tk
	D. Mobile Command Center.	misc
	F. Yeah listen, we going to need all hands,	coa
	we've got numerous trapped on the West Side. Rescue 1 Squad.	kio
	D. Hello? Unit you're breaking up. Repeat your message.	itk
	F. People trapped on the West Side, lower Manhattan, K.	itk
	D. What unit is this?	itk
	F. Marine Battalion 8.	itk
	D. All right, Marine Battalion, we have help coming in. If you tell me exactly where you are I'll get you some help. Where are you?	itk
11:00	F. I can't read it. Building's on top of me.	itk
	D. Calling the Mobile Command Vehicle. Calling any unit at the scene of the World Trade Center.	misc
	F. Mobile Command Center to Manhattan, K.	misc
	D. Mobile Command Center, we have firefighters from 4 Engine responding to the location, off-duty members. You have members trapped on the West Side of Tower No. 1. We believe it's Captain Fuentes. He's unable to give us his exact location. Reported to be several members trapped.	coa
	Do you have that message and copy it?	itk
	F. Ten-four, Manhattan. I got it. I relayed it to Chief Blakees [?]. He was on his way up with several members, K.	itk
	D. Ten-four.	misc
	F. Engine 7 calling from Ladder 1-2-4.	misc
	D. Calling the Mobile Command Vehicle.	misc
	F. Go ahead, Manhattan.	misc
	D. Be advised. I have a third alarm assignment sitting in Brooklyn waiting to come over. Find out from the staff chief where he wants them.	tk
	F. All right, 10-4.	misc
	D. All right, 10-4. All right, who's acting 112?	itk
	F. Engine 7 to Manhattan, K.	misc
	D. Go ahead 7 Engine.	misc
11:01	F. Could you give me the location of Chief Blakees please?	itk
	D. We believe they're at the west side of building No. 1, on the west side of building No. 1.	itk
	F. Engine 7, 10-4. Be advised we're several units, we're transmitting out of Ladder 1-2-4. We don't have a rig or anything.	tk
	D. All right, we believe there are numerous members trapped in the vicinity of the west side of that building in the collapse zone.	tk

	F. West side of building one?	itk
	D. That's the best I can do for you. I'm getting that from a member who is trapped and unable to tell me where he is.	itk
	F. Ten-four. He's in a vehicle?	itk
	D. I don't know that.	itk
	D. Calling Captain Fuentes.	misc
	F. Command Post to dispatcher.	misc
	D. Go ahead Command Post.	misc
	F. ... Car 3 and Car 5, let them know that we're setting up a command post at Broadway and Vescey Street, K.	tk
	D. Mobile Command Vehicle. Mobile Command Vehicle.	misc
	F. ...	misc
11:02	D. Is this the Mobile Command Vehicle? Calling the Mobile Command Vehicle.	itk
	F. Go ahead, Manhattan.	misc
	D. All right, Broadway and Vescey is the new command post, Broadway and Vescey. If you can find Car 3 or Car 5 or any staff chief, let them know that.	tk
	F. Repeat your message. You cut out, Manhattan.	itk
	D. Broadway and Vescey reported to be the new command post, Broadway and Vescey. Give that information to Car 3 or Car 5.	tk
	F. Be advised I have Chief Nigro [?] in the vehicle at this time, K.	tk
	D. All right, 10-4. Advise Chief Nigro ...	misc
	F. ...	misc
	D. Other unit calling Manhattan.	misc
	F. ..., K.	misc
	D. What unit?	itk
	F. Yeah, we need some relief here. We are the collapse unit [?]. This is Captain Fuentes and a couple other members, K.	rta
	D. Are you trapped, Captain?	itk
	F. ...	itk
	D. Captain Fuentes, are you trapped?	itk
	F. Ten-four.	itk
11:03	F. Mobile Command to Manhattan, K.	misc
	D. Go ahead Mobile Command.	misc
	F. What units do you have at Broadway and Vescey at this time?	itk
	D. Unknown, K. We're not sure.	tk
	You're going to have to send somebody over there.	coa
	Also be advised that we're in radio contact with Captain Fuentes and his people. They are trapped. He's trying to give me a location but he's unable to.	kio
	F. All right, 10-4. Like I said, Chief Blakees is on his way up with members. He's trying to get in to them now. As soon as Mobile Command Center can we're going to head out to Broadway and Vescey, K.	tk
	D. Ten-four.	misc
	D. Calling Captain Fuentes.	misc
	F. ...	misc
	D. All units standby. Calling Captain Fuentes.	misc
	F. ... Manhattan.	misc
	D. Is this Captain Fuentes?	itk
	F. Ten-four.	itk

	D. All right. We have help on the way to you Cap, we believe that you're in the west side of the No. 1 World Trade Center, out in front in the collapse zone. Is that correct?	itk
	F. In the collapse zone, 10-4.	itk
	D. All right. We're sending you some help.	itk
11:04	F. Engine 7 and Ladder 1 members have received that message.	tk
	Let them know.	rta
	D. All right. Seven Engine and 1 Truck's members are on the way and the staff chief is aware of your location, Cap. Just standby, we'll be there in a little while.	tk
	D. Another unit calling. Any other unit calling Manhattan?	itk
	F. Division 6, we have a command post set up on Broadway and Vescey Street, K.	tk
	D. All right. Division 6, be advised there's a full third alarm assignment sitting in Brooklyn. Do you want them to report to Broadway and Vescey?	itk
	F. ... 6.	misc
	D. All right. They're actually on the Manhattan side of the Brooklyn Bridge. If you need them let us know.	tk
	F. Division 6 to Manhattan, absolutely. Send them to Broadway and Vescey right all Park Row.	coa
	D. All right, 10-4.	misc
	D. All units who are responding to the staging area at the Brooklyn Bridge are to report in to Broadway and Vescey Streets,	coa
	Broadway and Vescey Streets.	cu
	F. Four-two Battalion to Manhattan.	misc
	D. Four-two Battalion.	misc
11:05	F. Four-two Battalion has the third alarm assignment right now on Chambers between Church and the bridge. You're redirecting us?	tsu
	D. Four-two Battalion, I want you to take that whole third alarm to Broadway and Vescey, hook up with Division 6 acting Division 1. He will give you further instructions.	tsu
	F. Four-two, 10-4.	misc
	D. All right.	misc
	F. Ladder 4-7 acting Ladder 6 to Manhattan.	misc
	F. This is Command Post.	misc
	F. Four-two Battalion to Manhattan.	misc
	D. Go ahead Battalion 4-2.	misc
	F. You want us to walk into that spot or bring rigs?	itk
	D. Get as close to that location as you can without being in the collapse zone and you get the members - they're looking for manpower.	itk
	F. Ten-four.	misc
	D. Four-two, they're looking for manpower and tools. You have members trapped in the street in collapse zones all over the World Trade Center.	cu
	F. Ten-four.	misc
	F. Safety to Command Post.	misc
	D. Safety, go ahead.	misc
	F. ... we got about 10 units that reported in from the Brooklyn to the Battery.	tk
	D. What unit is this?	itk
11:06	F. This is Safety Command.	itk

	We're on West and Albany. We've got about 10 units.	tk
	D. Unit, standby. Go ahead 4 Adam.	rta
	F. Safety to Rescue.	misc
	D. Calling Battalion 4-2.	misc
	F. Four-one for the 4-2, go ahead.	misc
	D. Car 4 Adam has redirected you. Go into West and Chambers Street with your assignment, West and Chambers and meet Car 4 Adam.	coa
	F. Four-one, 10-4. Can you announce that over the radio please for all these units?	itk
	D. All Brooklyn units that were responding in to the fire in Manhattan at the World Trade Center, go to West and - Broadway and Vescey Street, Broadway and Vescey Street for all the first units coming into the scene of the World Trade Center. Four-one and 4-2 Battalions, you got that?	cu
	F. Four-one, 10-4.	misc
11:07	D. All right, calling Division 6 acting 1.	misc
	F. Division 6 acting Division 1, have all officers report in when they park on Park Row to Chief Brandies [sp?]. You got that Manhattan, K?	coa
	F. ... to Rescue Battalion.	misc
	D. Everybody standby unless urgent.	rta
	F. Urgent.	misc
	D. Go ahead urgent.	misc
	F. I'm trapped here from the previous collapse. I need to make it out, K.	tk

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APPENDIX C: DIFFERENCES IN INTER-RATER RELIABILITY

Table 28. Differed Codes.

Coder 1	Coder 2	Final Code
rta	tk	rta
cmm	tk	cmm
cmm	tk	cmm
ct	tk	ct
tk	misc	tk
tk	misc	tk
itk	misc	itk
itk	misc	itk
tk	cu	cu
tk	cu	cu
tk	sa	sa
tk	sa	sa
tk	cmm	cmm
tk	cmm	cmm
imm	tk	imm
cmm	tk	cmm
imm	tk	imm
cmm	tk	cmm
imm	tk	tk
cmm	tk	cmm
tk	shk	tk
cmm	tk	cmm
kio	tk	kio
imm	tk	imm
cmm	tk	cmm
imm	tk	imm
shk	tk	shk
shk	tk	shk
tk	cu	cu
tk	cu	cu
itk	cu	cu
itk	cu	cu
tk	kio	kio
shk	itk	itk
itk	tsu	tsu
coa	tsu	tsu
Total	36	

Table 29. Discussed Codes.

Coder 1	Coder 2	Final Code
cu	tk	cu
imm	tk	imm
imm	cu	imm
dti	tk	dti
imm	tk	imm
ct	tk	ct
tsu	tk	tsu
cmm	tk	cmm
tsu	tk	tsu
imm	tk	imm
sa	tk	sa
shk	itk	itk
shk	itk	itk
imm	tk	tk
cu	tpr	tpr
itk	tpr	tpr
cu	tpr	tpr
itk	tpr	tpr
cmm	cmm	cmm
kio	kio	kio
kio	kio	kio
cmm	cmm	cmm
sa	sa	sa
sa	sa	sa
sa	sa	sa
kio	kio	kio
kio	kio	kio
tk	tk	tk
imm	imm	imm
csg	csg	csg
csg	csg	csg
cmm	cmm	cmm
cmm	cmm	cmm
imm	imm	imm
sa	sa	sa
aro	aro	aro
coa	coa	coa
sa	sa	sa
cu	cu	cu
tn	tn	tn
shk	shk	shk

Coder 1	Coder 2	Final Code
shk	shk	shk
shk	shk	shk
cmm	cmm	cmm
sa	sa	sa
tn	tn	tn
tk	tk	tk
kio	kio	kio
cu	cu	cu
cu	cu	cu
cu	cu	cu
Total	51	

Table 30. Coders Debating *Team Knowledge Development*, *tk*.

Coder 1	Coder 2	Final Code
cu	tk	cu
imm	tk	imm
dti	tk	dti
imm	tk	imm
ct	tk	ct
tsu	tk	tsu
rta	tk	rta
cmm	tk	cmm
tsu	tk	tsu
imm	tk	imm
sa	tk	sa
cmm	tk	cmm
cmm	tk	cmm
ct	tk	ct
tk	misc	tk
tk	misc	tk
tk	cu	cu
tk	cu	cu
tk	sa	sa
tk	sa	sa
tk	cmm	cmm
tk	cmm	cmm
imm	tk	tk
imm	tk	imm
cmm	tk	cmm
imm	tk	imm
cmm	tk	cmm
imm	tk	tk

Coder 1	Coder 2	Final Code
cmm	tk	cmm
tk	shk	tk
cmm	tk	cmm
kio	tk	kio
imm	tk	imm
cmm	tk	cmm
tk	tk	tk
imm	tk	imm
shk	tk	shk
shk	tk	shk
tk	cu	cu
tk	cu	cu
tk	kio	kio
tk	tk	tk
Total	42	

Table 31. Debated Codes Where Another Code was Decided Upon Instead of *Team Knowledge Development*, *tk*.

Coder 1	Coder 2	Final Code
cu	tk	cu
imm	tk	imm
dti	tk	dti
imm	tk	imm
ct	tk	ct
tsu	tk	tsu
rta	tk	rta
cmm	tk	cmm
tsu	tk	tsu
imm	tk	imm
sa	tk	sa
cmm	tk	cmm
cmm	tk	cmm
ct	tk	ct
tk	cu	cu
tk	cu	cu
tk	sa	sa
tk	sa	sa
tk	cmm	cmm
tk	cmm	cmm
imm	tk	imm
cmm	tk	cmm

Coder 1	Coder 2	Final Code
imm	tk	imm
cmm	tk	cmm
cmm	tk	cmm
cmm	tk	cmm
kio	tk	kio
imm	tk	imm
cmm	tk	cmm
imm	tk	imm
shk	tk	shk
shk	tk	shk
tk	cu	cu
tk	cu	cu
tk	kio	kio
Total	35	

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APPENDIX D: CHI SQUARE RESULTS

Table 32. Observed Values for all codes across all Cognitive Categories.

observed

CODE NUMBER	1	2	3	4	5	6	7
CODE	dti	imm	itk	tk	ko	vrn	cu
Category 1	1	5	24	34	0	0	3
Category 2	1	1	147	65	0	0	5
Category 3	0	4	52	44	0	0	0
Category 4	0	4	102	67	0	0	8
TOTAL	2	14	325	210	0	0	16

CODE NUMBER	8	9	10	11	12	13	14
CODE	kio	ica	tsu	sa	cmm	cs	tn
Category 1	1	0	4	0	4	0	0
Category 2	0	0	0	5	9	1	0
Category 3	3	0	0	5	5	0	0
Category 4	4	0	2	3	4	0	1
TOTAL	8	0	6	13	22	1	1

CODE NUMBER	15	16	17	18	19	20	21
CODE	tpv	ct	shk	sag	csg	aro	misc
Category 1	0	1	0	0	0	0	129
Category 2	3	2	0	0	0	0	330
Category 3	0	0	0	0	0	0	165
Category 4	0	0	5	0	2	1	225
TOTAL	3	3	5	0	2	1	849

CODE NUMBER	22	23	
CODE	coa	rta	N
Category 1	14	5	225
Category 2	41	26	636
Category 3	15	12	305
Category 4	22	10	460
TOTAL	92	53	1626

Table 33. Expected Values for all codes across all Cognitive Categories.

expected							
CODE NUMBER	1	2	3	4	5	6	7
CODE	dti	imm	itk	tk	ko	vrn	cu
Category 1	0.2363	1.6543	38.4039	24.8148	0.0000	0.0000	1.8907
Category 2	0.7725	5.4074	125.5291	81.1111	0.0000	0.0000	6.1799
Category 3	0.3527	2.4691	57.3192	37.0370	0.0000	0.0000	2.8219
Category 4	0.6384	4.4691	103.7478	67.0370	0.0000	0.0000	5.1076
TOTAL	2	14	325	210	0	0	16

CODE NUMBER	8	9	10	11	12	13	14
CODE	kio	ica	tsu	sa	cmm	cs	tn
Category 1	0.9453	0	0.7090	1.5362	2.5996	0.1182	0.1182
Category 2	3.0899	0	2.3175	5.0212	8.4974	0.3862	0.3862
Category 3	1.4109	0	1.0582	2.2928	3.8801	0.1764	0.1764
Category 4	2.5538	0	1.9153	4.1499	7.0229	0.3192	0.3192
TOTAL	8	0	6	13	22	1	1

CODE NUMBER	15	16	17	18	19	20	21
CODE	tpr	ct	shk	sag	csg	aro	misc
Category 1	0.3545	0.3545	0.5908	0	0.2363	0.1182	100.3228
Category 2	1.1587	1.1587	1.9312	0	0.7725	0.3862	327.9206
Category 3	0.5291	0.5291	0.8818	0	0.3527	0.1764	149.7354
Category 4	0.9577	0.9577	1.5961	0	0.6384	0.3192	271.0212
TOTAL	3	3	5	0	2	1	849

CODE NUMBER	22	23	
CODE	coa	rta	N
Category 1	10.8713	6.2628	225
Category 2	35.5344	20.4709	636
Category 3	16.2257	9.3474	305
Category 4	29.3686	16.9189	460
TOTAL	92	53	1626

Table 34. Chi Square Values for all codes across all Cognitive Categories.

**Chi Square
Values**

CODE NUMBER	1	2	3	4	5	6	7
CODE	dti	imm	itk	tk	ko	vrn	cu
Category 1	2.4677	6.7663	5.4024	3.3999	#DIV/0!	#DIV/0!	0.6509
Category 2	0.0670	3.5923	3.6725	3.2002	#DIV/0!	#DIV/0!	0.2253
Category 3	0.3527	0.9491	0.4936	1.3090	#DIV/0!	#DIV/0!	2.8219
Category 4	0.6384	0.0492	0.0294	0.0000	#DIV/0!	#DIV/0!	1.6380
TOTAL	3.5259	11.3570	9.5979	7.9091			5.3360

CODE NUMBER	8	9	10	11	12	13	14
CODE	kio	ica	tsu	sa	cmm	cs	tn
Category 1	0.0032	#DIV/0!	15.2762	1.5362	0.7543	0.1182	0.1182
Category 2	3.0899	#DIV/0!	2.3175	0.0001	0.0297	0.9753	0.3862
Category 3	1.7897	#DIV/0!	1.0582	3.1966	0.3233	0.1764	0.1764
Category 4	0.8190	#DIV/0!	0.0037	0.3186	1.3012	0.3192	1.4518
TOTAL	5.7018		18.6556	5.0515	2.4085	1.5890	2.1326

CODE NUMBER	15	16	17	18	19	20	21
CODE	tpr	ct	shk	sag	csg	aro	misc
Category 1	0.3545	1.1754	0.5908	#DIV/0!	0.2363	0.1182	8.1974
Category 2	2.9259	0.6108	1.9312	#DIV/0!	0.7725	0.3862	0.0132
Category 3	0.5291	0.5291	0.8818	#DIV/0!	0.3527	0.1764	1.5561
Category 4	0.9577	0.9577	7.2591	#DIV/0!	2.9036	1.4518	7.8147
TOTAL	4.7671	3.2730	10.6630		4.2652	2.1326	17.5814

CODE NUMBER	22	23
CODE	coa	rta
Category 1	0.9005	0.2546
Category 2	0.8407	1.4934
Category 3	0.0926	0.7527
Category 4	1.8488	2.8294
TOTAL	3.6825	5.3302
Chi Square Value	124.9597	

Table 35. Alpha and P values for a Chi Square analysis with 51 degrees of freedom.

alpha values	0.05	0.01	0.001
p-values	68.67	77.39	87.97

Table 36. Alpha and P values for a Chi Square analysis with 17 degrees of freedom.

alpha values	0.05	0.01	0.001
p-values	27.59	33.41	40.79

Table 37. Expected Values for Category 1 versus Category 2.³²

expected						
CODE NUMBER	1	2	3	4	7	8
CODE	dti	imm	itk	tk	cu	kio
Category 1	0.5226	1.5679	44.6864	25.8711	2.0906	0.2613
Category 2	1.4774	4.4321	126.3136	73.1289	5.9094	0.7387
TOTAL	2	6	171	99	8	1

CODE NUMBER	10	11	12	13	15	16
CODE	tsu	sa	cmm	cs	tpr	ct
Category 1	1.0453	1.3066	3.3972	0.2613	0.7840	0.7840
Category 2	2.9547	3.6934	9.6028	0.7387	2.2160	2.2160
TOTAL	4	5	13	1	3	3

CODE NUMBER	21	22	23
CODE	misc	coa	rta
Category 1	119.9477	14.3728	8.1010
Category 2	339.0523	40.6272	22.8990
TOTAL	459	55	31

Table 38. Chi Square Values for Category 1 versus Category 2.

Chi Square Values

CODE NUMBER	1	2	3	4	7	8
CODE	dti	imm	itk	tk	cu	kio
Category 1	0.4360	7.5124	9.5762	2.5542	0.3956	2.0880
Category 2	0.1542	2.6577	3.3878	0.9036	0.1400	0.7387

³² In addition to *knowledge object development (ko)*, *individual visualization and representation of meaning (vrm)*, *iterative information collection and analysis (ica)*, and *solution adjustment against goal and exit criteria (sag)*, there are no values for *team negotiation of solution alternatives (tn)*, *sharing hidden knowledge (shk)*, *compare solution options against goal (csg)*, or *analyze, revise solution options (aro)* because there were no communication turns coded as these cognitive codes.

TOTAL	0.5902	10.1701	12.9641	3.4578	0.5355	2.8267
--------------	--------	---------	---------	--------	--------	--------

CODE NUMBER	10	11	12	13	15	16
CODE	tsu	sa	cmm	cs	tpr	ct
Category 1	8.3520	1.3066	0.1070	0.2613	0.7840	0.0595
Category 2	2.9547	0.4622	0.0378	0.0924	0.2773	0.0211
TOTAL	11.3067	1.7689	0.1448	0.3538	1.0613	0.0806

CODE NUMBER	21	22	23
CODE	misc	coa	rta
Category 1	0.6832	0.0097	1.1871
Category 2	0.2417	0.0034	0.4200
TOTAL	0.9248	0.0131	1.6070
Chi Square Value	47.8053		

Table 39. Expected Values for Category 1 versus Category 3.³³

expected

CODE NUMBER	1	2	3	4	7
CODE	dti	imm	itk	tk	cu
Category 1	0.4245	3.8208	32.2642	33.1132	1.2736
Category 3	0.5755	5.1792	43.7358	44.8868	1.7264
TOTAL	1	9	76	78	3

CODE NUMBER	8	10	11	12	16
CODE	kio	tsu	sa	cmm	ct
Category 1	1.6981	1.6981	2.1226	3.8208	0.4245
Category 3	2.3019	2.3019	2.8774	5.1792	0.5755
TOTAL	4	4	5	9	1

CODE NUMBER	21	22	23
CODE	misc	coa	rta
Category 1	124.8113	12.3113	7.2170

³³ In addition to *knowledge object development (ko)*, *individual visualization and representation of meaning (vrm)*, *iterative information collection and analysis (ica)*, and *solution adjustment against goal and exit criteria (sag)*, there are no values for *team agreement on a common solution (cs)*, *team negotiation of solution alternatives (tn)*, *team pattern recognition (tpr)*, *sharing hidden knowledge (shk)*, *compare solution options against goal (csg)*, or *analyze, revise solution options (aro)* because there were no communication turns coded as these cognitive codes.

Category 3	169.1887	16.6887	9.7830
TOTAL	294	29	17

Table 40. Chi Square Values for Category 1 versus Category 3.

Chi Square Values

CODE NUMBER	1	2	3	4	7
CODE	dti	imm	itk	tk	cu
Category 1	0.7801	0.3640	2.1168	0.0237	2.3403
Category 3	0.5755	0.2685	1.5616	0.0175	1.7264
TOTAL	1.3556	0.6325	3.6783	0.0413	4.0667

CODE NUMBER	8	10	11	12	16
CODE	kio	tsu	sa	cmm	ct
Category 1	0.2870	3.1203	2.1226	0.0084	0.7801
Category 3	0.2117	2.3019	1.5659	0.0062	0.5755
TOTAL	0.4987	5.4222	3.6885	0.0146	1.3556

CODE NUMBER	21	22	23
CODE	misc	coa	rta
Category 1	0.1406	0.2316	0.6810
Category 3	0.1037	0.1709	0.5024
TOTAL	0.2443	0.4025	1.1834
Chi Square Value	22.5841		

Table 41. Expected Values for Category 1 versus Category 4.³⁴

expected

CODE NUMBER	1	2	3	4	7	8
CODE	dti	imm	itk	tk	cu	kio
Category 1	0.3285	2.9562	41.3869	33.1752	3.6131	1.6423
Category 4	0.6715	6.0438	84.6131	67.8248	7.3869	3.3577
TOTAL	1	9	126	101	11	5

CODE NUMBER	10	11	12	14	16	17
CODE	tsu	sa	cmm	tn	ct	shk
Category 1	1.9708	0.9854	2.6277	0.3285	0.3285	1.6423

³⁴ In addition to *knowledge object development (ko)*, *individual visualization and representation of meaning (vrm)*, *iterative information collection and analysis (ica)*, and *solution adjustment against goal and exit criteria (sag)*, there are no values for *team agreement on a common solution (cs)*, or *team pattern recognition (tpr)* because there were no communication turns coded as these cognitive codes.

Category 4	4.0292	2.0146	5.3723	0.6715	0.6715	3.3577
TOTAL	6	3	8	1	1	5

CODE NUMBER	19	20	21	22	23
CODE	csg	aro	misc	coa	rta
Category 1	0.6569	0.3285	116.2774	11.8248	4.9270
Category 4	1.3431	0.6715	237.7226	24.1752	10.0730
TOTAL	2	1	354	36	15

Table 42. Chi Square Values for Category 1 versus Category 4.

Chi Square Values

CODE NUMBER	1	2	3	4	7	8
CODE	dti	imm	itk	tk	cu	kio
Category 1	1.3729	1.4130	7.3043	0.0205	0.1040	0.2512
Category 4	0.6715	0.6911	3.5728	0.0100	0.0509	0.1229
TOTAL	2.0444	2.1041	10.8771	0.0305	0.1549	0.3741

CODE NUMBER	10	11	12	14	16	17
CODE	tsu	sa	cmm	tn	ct	shk
Category 1	2.0893	0.9854	0.7166	0.3285	1.3729	1.6423
Category 4	1.0220	0.4820	0.3505	0.1607	0.6715	0.8033
TOTAL	3.1113	1.4674	1.0671	0.4891	2.0444	2.4457

CODE NUMBER	19	20	21	22	23
CODE	csg	aro	misc	coa	rta
Category 1	0.6569	0.3285	1.3921	0.4001	0.0011
Category 4	0.3213	0.1607	0.6809	0.1957	0.0005
TOTAL	0.9783	0.4891	2.0730	0.5958	0.0016
Chi Square Value	30.3481				

Table 43. Expected Values for Category 2 versus Category 3.³⁵

expected

CODE NUMBER	1	2	3	4	7
--------------------	---	---	---	---	---

³⁵ In addition to *knowledge object development (ko)*, *individual visualization and representation of meaning (vrm)*, *iterative information collection and analysis (ica)*, and *solution adjustment against goal and exit criteria (sag)*, there are no values for *team shared understanding development (tsu)*, *team negotiation of solution alternatives (tn)*, *sharing hidden knowledge (shk)*, *compare solution options against goal (csg)*, or *analyze, revise solution options (aro)* because there were no communication turns coded as these cognitive codes.

CODE	dti	imm	itk	tk	cu
Category 2	0.6759	3.3794	134.4995	73.6706	3.3794
Category 3	0.3241	1.6206	64.5005	35.3294	1.6206
TOTAL	1	5	199	109	5

CODE NUMBER	8	11	12	13	15
CODE	kio	sa	cmm	cs	tpr
Category 2	2.0276	6.7588	9.4623	0.6759	2.0276
Category 3	0.9724	3.2412	4.5377	0.3241	0.9724
TOTAL	3	10	14	1	3

CODE NUMBER	16	21	22	23
CODE	ct	misc	coa	rta
Category 2	1.3518	334.5590	37.8491	25.6833
Category 3	0.6482	160.4410	18.1509	12.3167
TOTAL	2	495	56	38

Table 44. Chi Square Values for Category 2 versus Category 3.

Chi Square Values

CODE NUMBER	1	2	3	4	7
CODE	dti	imm	itk	tk	cu
Category 2	0.1554	1.6753	1.1618	1.0205	0.7772
Category 3	0.3241	3.4934	2.4227	2.1279	1.6206
TOTAL	0.4796	5.1687	3.5845	3.1484	2.3978

CODE NUMBER	8	11	12	13	15
CODE	kio	sa	cmm	cs	tpr
Category 2	2.0276	0.4577	0.0226	0.1554	0.4663
Category 3	4.2281	0.9543	0.0471	0.3241	0.9724
TOTAL	6.2557	1.4120	0.0697	0.4796	1.4387

CODE NUMBER	16	21	22	23
CODE	ct	misc	coa	rta
Category 2	0.3109	0.0621	0.2623	0.0039
Category 3	0.6482	0.1295	0.5470	0.0081
TOTAL	0.9591	0.1917	0.8093	0.0120
Chi Square Value	26.4067			

Table 45. Expected Values for Category 2 versus Category 4.

expected						
CODE NUMBER	1	2	3	4	7	8
CODE	dti	imm	itk	tk	cu	kio
Category 2	0.5803	2.9015	144.4927	76.5985	7.5438	2.3212
Category 4	0.4197	2.0985	104.5073	55.4015	5.4562	1.6788
TOTAL	1	5	249	132	13	4

CODE NUMBER	10	11	12	13	14	15
CODE	tsu	sa	cmm	cs	tn	tpr
Category 2	1.1606	4.6423	7.5438	0.5803	0.5803	1.7409
Category 4	0.8394	3.3577	5.4562	0.4197	0.4197	1.2591
TOTAL	2	8	13	1	1	3

CODE NUMBER	16	17	19	20	21	22
CODE	ct	shk	csg	aro	misc	coa
Category 2	1.1606	2.9015	1.1606	0.5803	322.0620	36.5584
Category 4	0.8394	2.0985	0.8394	0.4197	232.9380	26.4416
TOTAL	2	5	2	1	555	63

CODE NUMBER	23
CODE	rta
Category 2	1.2497
Category 4	1.7278
TOTAL	2.9775

Table 46. Chi Square Values for Category 2 versus Category 4.

Chi Square Values						
CODE NUMBER	1	2	3	4	7	8
CODE	dti	imm	itk	tk	cu	kio
Category 2	0.3035624	1.246113942	0.0435077	1.7562493	0.8577772	2.3211679
Category 4	0.419708	1.722887972	0.0601542	2.4282056	1.1859703	3.2092669
TOTAL	0.7232704	2.969001914	0.1036619	4.1844549	2.0437475	5.5304348

CODE NUMBER	10	11	12	13	14	15
CODE	tsu	sa	cmm	cs	tn	tpr
Category 2	1.1605839	0.027555892	0.2810961	0.3035624	0.580292	0.9106872

Category 4	1.6046334	0.038099016	0.3886459	0.419708	0.8023167	1.2591241
TOTAL	2.7652174	0.065654908	0.6697419	0.7232704	1.3826087	2.1698113

CODE NUMBER	16	17	19	20	21	22
CODE	ct	shk	csg	aro	misc	coa
Category 2	0.6071248	2.901459854	1.1605839	0.580292	0.1956491	0.5396261
Category 4	0.8394161	4.011583624	1.6046334	0.8023167	0.2705061	0.7460917
TOTAL	1.4465409	6.913043478	2.7652174	1.3826087	0.4661552	1.2857178
Chi Square Value	40.567706					

Table 47. Expected Values for Category 3 versus Category 4.³⁶

expected

CODE NUMBER	2	3	4	7	8
CODE	imm	itk	tk	cu	kio
Category 3	3.1895	61.3987	44.2549	3.1895	2.7908
Category 4	4.8105	92.6013	66.7451	4.8105	4.2092
TOTAL	8	154	111	8	7

CODE NUMBER	10	11	12	14	17
CODE	tsu	sa	cmm	tn	shk
Category 3	0.7974	3.1895	3.5882	0.3987	1.9935
Category 4	1.2026	4.8105	5.4118	0.6013	3.0065
TOTAL	2	8	9	1	5

CODE NUMBER	19	20	21	22	23
CODE	csg	aro	misc	coa	rta
Category 3	0.7974	0.3987	155.4902	14.7516	8.7712
Category 4	1.2026	0.6013	234.5098	22.2484	13.2288
TOTAL	2	1	390	37	22

³⁶ In addition to *knowledge object development (ko)*, *individual visualization and representation of meaning (vrm)*, *iterative information collection and analysis (ica)*, and *solution adjustment against goal and exit criteria (sag)*, there are no values for *individual conversion of data to information (dti)*, *team agreement on a common solution (cs)*, *team pattern recognition (tpr)*, *sharing hidden knowledge (shk)*, *compare solution options against goal (csg)*, or *analyze, revise solution options (aro)* because there were no communication turns coded as these cognitive codes.

Table 48. Chi Square Values for Category 3 versus Category 4.

Chi Square Values					
CODE NUMBER	2	3	4	7	8
CODE	imm	itk	tk	cu	kio
Category 3	0.2059	1.4387	0.0015	3.1895	0.0157
Category 4	0.1365	0.9539	0.0010	2.1148	0.0104
TOTAL	0.3425	2.3927	0.0024	5.3043	0.0261

CODE NUMBER	10	11	12	14	17
CODE	tsu	sa	cmm	tn	shk
Category 3	0.7974	1.0277	0.5554	0.3987	1.9935
Category 4	0.5287	0.6814	0.3683	0.2644	1.3218
TOTAL	1.3261	1.7090	0.9237	0.6630	3.3152

CODE NUMBER	19	20	21	22	23
CODE	csg	aro	misc	coa	rta
Category 3	0.7974	0.3987	0.5816	0.0042	1.1885
Category 4	0.5287	0.2644	0.3856	0.0028	0.7880
TOTAL	1.3261	0.6630	0.9673	0.0070	1.9766
Chi Square Value		20.9450			

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APPENDIX E: LOSSES OF SITUATIONAL AWARENESS

Table 49. Losses of Situational Awareness.

SITUATIONAL AWARENESS LOST			FIX	EFFECTS
TIME	SPEAKER	MESSAGE		
0904	FIELD	Marine 6 to Manhattan	None.	Not corrected.
	DISPATCH	Marine 6, go with your message.		
	FIELD	Marine 6, that plane was a large bomber-style green aircraft into the second tower, be advised.		
	DISPATCH	All right, 10-4.		
0913	FIELD	Car 9 to Manhattan, K.	Car 9 came back on the radio to correct dispatch, saying they wanted the mobile command vehicle, not field comm..	None, corrected early enough.
	DISPATCH	Car 9, go ahead.		
	FIELD	Would you advise the mobile command vehicle to come in on West and Liberty Street, West and Liberty Street.		
	DISPATCH	I already advised them.		
	FIELD	What's their E.T.A.?		
	DISPATCH	Manhattan calling Field Comm.		
0930	FIELD	Engine 317 to Manhattan, urgent.	None.	The firefighters working in whichever building the elevators were not coming down in would have had continued access to elevators, but instead were told not to use them because of vague information.
	DISPATCH	Engine 317, go.		
	FIELD	I've got ... from the Port Authority telling me that the elevators are on the 44th floor. Don't use them, they're about to come down.		
	DISPATCH	Is that going to be for No. 2 or No. 1 World Trade.		
	FIELD	Wasn't sure. I'd say go with both.		
	DISPATCH	Attention all companies operating at the fifth alarm for both World Trade Centers, the elevators, the Port Authority reports the elevators on the No. 4-4 floor are about to come down. All companies operating		

SITUATIONAL AWARENESS LOST				
		at No. 1 and No. 2 World Trade Center at the fifth alarm, do not use the elevators. They are about to come down as per the Port Authority on the No. 4-4 floor. Field Comm., receive that urgent? Manhattan to Ladder 2-1, K.		

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